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# SELECTED WATER RESOURCES ABSTRACTS

VOLUME 21, NUMBER 7
JULY 1988

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# SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
U.S. Department of the Interior

**VOLUME 21, NUMBER 7**
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W88-05108 -- W88-05917

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

# PREFACE

**Selected Water Resources Abstracts,** a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

**Selected Water Resources Abstracts** is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several services of the Water Resources Scientific Information Center. The cumulative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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**COASTAL-A DISTRIBUTED HYDROLOGIC SIMULATION MODEL FOR LOWER COASTAL PLAIN WATERSHEDS IN GEORGIA,**
Georgia Univ., Athens. Graduate School.
C. H. Sun.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8613516. Ph.D Dissertation, 1985. 217 p, 22 tab, 66 ref, append.

Descriptors: *Model studies, *Rainfall-runoff relationships, *Hydrologic models, Groundwater movement, Watersheds, Fortran, Computer programs, Groundwater runoff, Evapotranspiration, Rainfall penetration, Moisture content, Soil water, Groundwater level, Stream discharge, Simulation analysis, Mathematical models.

A distributed, physically-based watershed hydrologic simulation model for Georgia Lower Coastal Plain watersheds was developed by combining surface and subsurface simulation models. The model was tested on the Hurricane Creek watershed to compare its performance with that of five other watershed hydrologic models. The model simulates daily and spatial variations in watershed hydrology resulting from meterological conditions and variations in man's activities. It uses input data which can be obtained easily from topographic maps, soil surveys, aerial photographs, and published climatological data. COSTAL is written in FORTRAN-77 and designed to run on an upgraded IBM personal computer. It simulates the processes of rainfall interception, unsaturated and saturated groundwater flow, actual evapotranspiration, and soil moisture redistribution. Outputs are daily evaportranspiration, soil moisture status in the unsaturated soil zone, stream discharge, and average groundwater level for each grid element. (Cremmins-AEPCO)
W88-05204

**EVALUATION OF SOME EMPIRICAL METHODS FOR FLOOD FREQUENCY ANALYSIS, 2. DATA AND COMPUTER PROGRAMS,**
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W88-05234

**EVALUATION OF PARAMETER ESTIMATION METHOD FOR FLOOD FREQUENCY ANALYSIS: COMPUTER PROGRAMS,**
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W88-05235

**ANNUAL FLOW STATISTICS AND DROUGHT CHARACTERISTIC FOR GAGED AND UNGAGED STREAMS IN IDAHO,**
Idaho Univ., Moscow. Dept. of Civil Engineering.
D. Horn.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-137583/AS. Price codes: A09 in paper copy; A01 in microfiche. Project No. USGS G1222-03. Contract No. 14-08-0001-G1222. IDaho Water Resources Research Institute, Moscow, Completion Report, May 1987. 170 p, 16 fig, 9 tab, 30 ref, 4 append.

Descriptors: *Statistical analysis, *Drought risk, *Idaho, *Risks, *Drought probability, Streamflow, Annual runoff, Flow characteristics, Data augmentation.

This study addresses the problem of drought risk assessment for streams within the State of Idaho. Hydrologists and engineers involved in the planning of surface water projects have long recognized the need to deal with hydrologic uncertainty, but most of the attempts to date have relied on the use of observed historical critical drought periods. However, since these periods vary from one location to another within the state, their true probabilities of recurrence have not been adequately defined. Moreover, for ungaged streams, or for locations with a limited period of gaged data, the problem of assessing drought probabilities has remained almost totally unresolved. (USGS)
W88-05236

**RAPID WATER TABLE RESPONSES TO RAINFALL IN A NORTHERN PEATLAND ECOSYSTEM,**
George Mason Univ., Fairfax, VA. Dept. of Biology.
F. D. Heliotis, and C. B. DeWitt.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1011-1016, December 1987. 2 fig, 4 tab, 13 ref.

Descriptors: *Water table, *Rainfall, *Groundwater movement, *Surface-groundwater relations, *Peat bogs, *Wetlands, Rainfall infiltration, Rainfall penetration, Rainfall intensity, Precipitation, Water table, Water table fluctuations, Water level fluctuations, Water level, Wastewater treatment, Flood control, Simulation, Michigan, Lisse effect, Wieringermeer effect.

Two types of rapid water table responses to rain were observed in a northern Michigan peatland. The first, called the Lisse effect, occurred during rains of high intensity when the infiltrating water acted as a tightly closing lid that forced the water table to rise to the level required to compensate for the pressure increase. The second, called the Wieringermeer effect, was a rapid rise of the water table to the surface due to the conversion of capillary to phreatic water and was always followed by an equally rapid decline after cessation of the rainfall. These phenomena were simulated in the laboratory and the critical parameters that determine their occurrence were estimated. The recognition of the importance of the capillary fringe is essential in evaluating the role of wetlands in flood control and in wastewater treatment. (Author's abstract)
W88-05402

**WATER BALANCE OF PACIFIC ATOLLS,**
Hawaii Univ., Honolulu. Dept. of Geography.
For primary bibliographic entry see Field 2D.
W88-05416

**PATTERNS OF WATERSHED MONTHLY RUNOFF,**
W. M. Snyder, and A. W. Thomas.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1133-1140, December 1987. 8 fig, 3 tab, 16 ref.

Descriptors: Descriptors:* Rainfall-runoff relationships, *Runoff, *Watersheds, *Hydrologic models, Pattern analysis, Sliding polynomials, Precipitation, Rainfall, Seasonal variation, Hydrologic budget, Surface runoff, Model studies, Mathematical studies, Mathematical equations, Least squares method, Standard deviation.

Two dimensional sliding polynomials were adapted to pattern analysis of watershed monthly rainfall and runoff. Contours of runoff $^2$ the two-dimensional space of time and rainfall are constructed on a grid of 16 nodes whose values are determined by least squares. This method is form free, hence derived patterns are not biased to selected functional forms, but can directly represent the smoothed data. Values of the nodes are localized averages of the data constrained by required mathematical continuity across the grid of values. An advantage of the method is that the standard deviation can be calculated for each node, thus producing patterns of uncertainty of the deterministic component revealed by the data. (Author's abstract)
W88-05417

**REAL-TIME SIMULATION MODEL FOR THE MONONGAHELA RIVER BASIN,**
Utah Water Research Lab., Logan.
D. H. Hoggan, J. C. Peters, and W. Loehlein.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1141-1147, December 1987. 7 fig, 7 ref.

Descriptors: *Water yield, *Streamflow forecasting, *Snowmelt-runoff relationships, *Runoff forecasting, *Model studies, Snow accumulation, Runoff, Snow, Accumulation, Snowmelt, Forecasting, Runoff volume, Monongahela River Basin, Pennsylvania, River basins, Simulation, Mathematical studies, Mathematical equations, Reservoir storage, Reservoirs, Multipurpose reservoirs, Reservoir management.

The Pittsburgh District, U.S. Army Corps of Engineers, is responsible for operating two multipurpose reservoirs in the 7384 square mile Monongahela Basin. A third reservoir, presently under construction, will soon be operating. The real-time forecasting of runoff for operational purposes requires simulation of snow accumulation and snowmelt throughout the Basin during the winter season. The capabilities of SNOSIM, a model being developed for performing such simulation, are described. Data inputs are limited to temperature, snow depth, precipitation, and snow density. Obtaining the correct timing of runoff from subbasins is the most significant problem. The factors that have the greastest effect on timing are the weighting factors used in subbasin averaging and the lag factor. Good spatial averaging of snow depth data measured at stations is difficult to achieve; further research is needed in this area. (Wood-PTT)
W88-05418

**REAL-TIME LANDSLIDE WARNING DURING HEAVY RAINFALL,**
Geological Survey, Menlo Park, CA.
D. K. Keefer, R. C. Wilson, R. K. Mark, E. E. Brabb, and W. M. Brown.
Science SCIEAS, Vol. 238, No. 4829, p 921-925, November 13, 1987. 3 fig, 31 ref.

Descriptors: *Landslide forecasting, *Landslides, *Warning systems, *Rainfall-landslide relationships, *Rainstorms, *Erosion, Forecasting, Rainfall, San Francisco, California, Mathematical equations, Geologic properties, Monitoring, Prediction.

A real-time system for issuing warnings of landslides during major storms is being developed for the San Francisco Bay region, California. The system is based on empirical and theoretical relations between rainfall and landslide initiation, geologic determination of areas susceptible to landslides, real-time monitoring of a regional network of telemetering rain gages, and National Weather Service precipitation forecasts. This system was used to issue warnings during the storms of 12 to 21 February 1986, which produced 800 millimeters of rainfall in the region. Although analysis of the storms suggests that modifications and additional developments are needed, the system successfully predicted the times of major landslide events. It could be used as a prototype for systems in other landslide-prone regions. (Author's abstract)
W88-05505

**CYCLES IN FINITE SAMPLES AND CUMULATIVE PROCESSES OF HIGHER ORDERS,**
National Hydrology Research Inst., Saskatoon (Saskatchewan).
For primary bibliographic entry see Field 7C.
W88-05534

**NEAR REAL-TIME FORECASTING OF LARGE LAKE SUPPLIES,**
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
T. E. Croley, and H. C. Hartmann.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 6, p 810-823, November, 1987. 3 tab, 30 ref.

Descriptors: *Forecasting, *Water supply, *Lake basins, *Model studies, *Moisture availability, *Water level, *Lake Superior, Basins, Lakes, Runoff forecasting, Weather, Precipitation, Runoff, Error analysis, Climatology, Evaporation, Lake evaporation.

## Field 2—WATER CYCLE

### Group 2A—General

The Great Lakes Environmental Research Laboratory (GLERL) has developed conceptual model-based techniques for making outlooks of basin moisture conditions, basin runoff, water supplies, and lake levels several months into the future for large lake basins. The techniques consider the water stored in the basins about the lakes and the uncertainty of future meteorologic conditions. The current moisture storage of the basin of Lake Superior is estimated with GLERL's tank-cascade runoff model, applied to each of the subbasins about the lake, and with near real-time meteorology. Historic meteorologic sequences were selected to represent anticipated meteorology, based on the National Weather Service monthly and seasonal forecasts of precipitation and air temperature probabilities, for use with the runoff model to generate near real-time outlooks. Error analysis for the Lake Superior Basin identifies the outlook error components and their relative magnitudes, indicates the outlook is superior to climatology, and suggests that improvements await better weather forecasting and lake evaporation modeling. (Author's abstract)
W88-05616

**HYDROLOGY AND WATER RESOURCES IN TROPICAL REGIONS,**
J. Balek.
Elsevier, Amsterdam, The Netherlands. 1983. 271 p.

Descriptors: *Tropical regions, *Water resources development, *Rivers, *Surface-groundwater relations, Hydrologic systems, Hydrologic budget, River basins, Lakes, Swamps, Ecology, Geography, Climate.

An increasing interest in the water economy of the developing countries, the majority of which are located within the tropics, has resulted in the publication of a great many papers, reports and texts on tropical waters and their management. This book is concerned with the behavior of tropical waters and various ecological, geographical and climatological conditions. The problems of water management in relation to agriculture and civil engineering are also examined. Tropical regions today are faced with extensive and rapid changes. Unfortunately man's impact on tropical hydro-ecology is predominantly negative. Coordinated action to prevent the situation from deteriorating further should be based on a thorough understanding of natural water regimes and the changes and development they undergo. The discussion here centers around chapters on: (1) tropical rivers; (2) climatology of the tropics; (3) hydrological cycle and water balance of a tropical basin; (4) rivers and basins; (5) groundwater and water in soil; (6) lakes and swamps; (7) hydrological extremes; and (8) water resources. (Lantz-PTT)
W88-05776

**GLACIAL HYDROLOGY,**
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
For primary bibliographic entry see Field 2C.
W88-05793

### 2B. Precipitation

**EXAMINATION OF SOX, NOX AND TRACE METAL WASHOUT RATIOS OVER THE WESTERN ATLANTIC OCEAN,**
General Motors Research Labs., Warren, MI. Environmental Science Dept.
For primary bibliographic entry see Field 5B.
W88-05123

**CONCENTRATION AND DEPOSITION OF NITRATE, SULFATE AND AMMONIUM AS A FUNCTION OF WIND DIRECTION FROM PRECIPITATION SAMPLES,**
State Univ. of New York at Stony Brook. Lab. for Planetary Atmospheres Research.
For primary bibliographic entry see Field 5B.
W88-05124

**ACID RAIN IN THE TROPICAL FORESTS OF THE IVORY COAST,**
Toulouse-3 Univ. (France). Lab. d'Aerologie.
For primary bibliographic entry see Field 5B.
W88-05125

**MIDWEST/WESTERN/EASTERN U.S. PRECIPITATION AND AEROSOL SULFATE: DIFFERENCES ATTRIBUTABLE TO NATURAL SOURCE INPUTS,**
Colorado Univ., Denver. Dept. of Physics.
For primary bibliographic entry see Field 5B.
W88-05126

**EXPECTED PH FOR HALVING SULFATE IN ADIRONDACK RAIN,**
Systech Engineering, Inc., Lafayette, CA.
For primary bibliographic entry see Field 5B.
W88-05161

**DISTRIBUTED DYNAMIC WATERSHED MODEL,**
Texas A and M Univ., College Station. Dept. of Civil Engineering.
K. W. Kim.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8625406. Ph.D Dissertation, 1986. 123 p, 39 fig, 6 tab, 98 ref.

Descriptors: *Model studies, *Watersheds, *Simulation analysis, *Hydrologic models, *Rainfall-runoff relationships, Simulated rainfall, Stream discharge, Computer models, Rainfall infiltration, Slope stabilization, Surface runoff, Roughness coefficient, Moisture content, Permeability coefficient.

A single-event, distributed rainfall runoff simulation was formulated using digital data to predict streamflow. A technique was developed for defining hydrologically homogeneous areas from readily measured watershed conditions. A computer algorithm to predict excess precipitation on each hydrologically homogeneous area and a hydraulic overland flow routing procedure were also developed. The relative importance of infiltration, surface slope, and roughness in determination of overland flow was studied. An algorithm of streamflow routing was constructed to predict a watershed outflow hydrograph due to a single storm. The results of simulation were compared with field observations and other simulation models. The model accurately simulated runoff for a single-event storm, given the appropriate parameters. The sensitivity analysis indicated that the most critical parameters were those factors which influence the infiltration capacity during the storm, mainly initial moisture content and saturated hydraulic conductivity of soil. (Cremmins-AEPCO)
W88-05207

**REGIONAL WATER AVAILABILITY AND GLOBAL CLIMATIC CHANGE: THE HYDROLOGIC CONSEQUENCES OF INCREASES IN ATMOSPHERIC CARBON DIOXIDE AND OTHER TRACE GASES,**
California Univ., Berkeley. Energy and Resources Group.
For primary bibliographic entry see Field 5C.
W88-05216

**SOME FEATURES OF THE GROWING SEASON PRECIPITATION FLUCTUATIONS IN THE INTERIOR PLAINS OF NORTH AMERICA,**
Ahmadu Bello Univ., Zaria (Nigeria). Dept. of Geography.
E. O. Oladipo.
Journal of Climatology JOUCD2, Vol. 7, No. 6, p 531-540, November-December, 1987. 4 fig, 23 ref.

Descriptors: *Temporal distribution, *Precipitation, *North America, *Climatology, *Statistical analysis, Distribution, Seasonal distribution, Storms, Thunderstorms, Rainfall, Fluctuations, Weather, Mathematical studies.

Long-term growing season precipitation series for the period 1931-1978 at 407 stations in the Interior Plains of North America and for stations with records dating back to 1875 were subjected to various statistical analyses in order to understand their inter-annual and long-term variability. The higher degree of spatial variability of seasonal precipitation series over the southern Plains indicated a higher frequency of occurrence of thunderstorms in the sub-region compared with the northern Plains and the Canadian Prairies. The test for normality by Fisher's statistic and the Geary coefficient indicated that about 20% of the precipitation series were not normally distributed. Subperiods analysis as tested by Cramer's test indicated that, although the 1941-1970 normal was wetter than the preceding non-overlapping 30-year normal period, there had been no significant secular change in the growing season precipitation in the Interior Plains, at least since 1911. Analysis of the precipitation anomalies decade by decade from the 1941-1970 averaged indicated that the 1940s and 1960s were generally wet, while other decades, especially the 1930s and 1950s were particularly dry. The 30-year period 1941-1970 was probably the most anomalously wet period in the 104-year time sequence. Results of the statistical analyses indicated no significant changes in some of the secular features of growing season precipitation totals in the Interior Plains. (Author's abstract)
W88-05308

**VARIATIONS OF DRY SPELLS IN MARSEILLES FROM 1865 TO 1984,**
Aix-Marseille-2 Univ., Aix en Provence (France). Inst. de Geographie.
A. Douguedroit.
Journal of Climatology JOUCD2, Vol. 7, No. 6, p 541-551, November-December, 1987. 7 fig, 5 tab, 28 ref.

Descriptors: *Drought, *Marseilles, *Temporal distribution, *Climatology, *Rainfall, Model studies, Seasonal distribution.

All the dry spells and long dry spells (lasting 30 days or more) of Marseilles, France were studied using daily data from 1865 to 1984. The study of dry spells provides a better characterization of the structure of a dry season than do monthly totals or means of rainfall. The dry season is characterized by the mean lengths of all dry spells and of the long dry spells (30 days or more), and by their persistence during 19 overlapping 30-year series. A model was investigated to fit the nonconstant probability of persistence of dry spells. This model, based on negative binomial distributions, permits the computation of the probability of occurrence of a dry spell > or = n days. The empirical distribution of the monthly dry spells according to their length is adjusted to the shifted negative binomial model, permitting the display of significant variations of probability of occurrence of dry spells of a chosen length during the summer months for the last 12 years at Marseilles. The model fits the observed data of many stations of the French Mediterranean coast rather well for the series 1955-1984 and for shorter series such as 1951-1975. (Doria-PTT)
W88-05309

**TIME SCALE OF THE SOIL HYDROLOGY USING A SIMPLE WATER BUDGET MODEL,**
IBM, Paris (France). Paris Scientific Center.
For primary bibliographic entry see Field 2G.
W88-05311

**OXIDIZED NITROGEN IN PRECIPITATION, THROUGHFALL, AND STREAMFALL FROM A FORESTED WATERSHED IN OKLAHOMA,**
Geological Survey, Huron, SD. Water Resources Div.
For primary bibliographic entry see Field 4C.
W88-05409

**EFFECTS OF ACIDIC DEPOSITION ON THE CHEMISTRY OF HEADWATER STREAMS: A COMPARISON BETWEEN HUBBARD**

BROOK, NEW HAMPSHIRE, AND JAMIESON CREEK, BRITISH COLUMBIA,
Syracuse Univ., NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W88-05433

BIOGENIC SULFUR AND THE ACIDITY OF RAINFALL IN REMOTE AREAS OF CANADA,
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W88-05503

ANALYSIS OF EVENT-BASED PRECIPITATION DATA WITH A VIEW TOWARD MODELING,
Washington Univ., Seattle. Dept. of Statistics.
For primary bibliographic entry see Field 5B.
W88-05528

CONSTANT RATE RAINFALL INFILTRATION: A VERSATILE NONLINEAR MODEL: 1. ANALYTIC SOLUTION,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
For primary bibliographic entry see Field 2G.
W88-05539

CONSTANT RATE RAINFALL INFILTRATION: A VERSATILE NONLINEAR MODEL: 2. APPLICATION OF SOLUTIONS,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
For primary bibliographic entry see Field 2G.
W88-05540

TREE RING-BASED RECONSTRUCTION OF ANNUAL PRECIPITATION IN THE SOUTH-CENTRAL UNITED STATES FROM 1750 TO 1980,
Oak Ridge National Lab., TN. Environmental Sciences Div.
T. J. Blasing, D. W. Stahle, and D. N. Duvick.
Water Resources Research WRERAO, Vol. 24, No. 1, p 163-171, January 1988. 6 fig, 1 tab, 45 ref.
NSF Grants ATM-8120615 and ATM-8412912. NSF Interagency Agreement BSR 8115316. DOE Contract DE-AC05-840R21400.

Descriptors: *Paleoclimatology, *Annual precipitation, *Dendroclimatology, *Drought, *Precipitation, *Trees, South-central United States, Regression analysis, Mathematical studies, Mathematical equations, Oak trees, Greenhouse effects, Prediction.

A 231-year reconstruction of annual precipitation, from 1750 through 1980 A.D., was developed from 10 tree ring chronologies (9 post oak, Quercus stellata, and 1 white oak, Q. alba, series) in the south-central United States. Straight line regression was used to calibrate regionally averaged precipitation with ring width data, and the derived reconstruction was verified with independent climatic data and historical evidence. A variance trend in the tree ring data, which may have resulted from non-climatic factors, was removed. The reconstructed precipitation series indicates that (1) a drought which appears to have been more severe than any in the instrumental record occurred about 1860 and (2) severe and prolonged droughts comparable to twentieth century events have occurred at roughly 15- to 25-year intervals throughout the past 231 years. It follows that serious droughts in the south-central United States could be expected to recur even in the absence of projected CO2-induced warming. (Author's abstract)
W88-05541

BACTERIAL UTILIZATION OF FORMIC AND ACETIC ACID IN RAINWATER,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2K.
W88-05633

CONCENTRATIONS, SPECIATION AND DECOMPOSITION OF ORGANOLEAD COMPOUNDS IN RAINWATER,
Essex Univ., Colchester (England). Dept. of Chemistry.
For primary bibliographic entry see Field 2K.
W88-05634

CLOUD PHYSICS STUDIES IN SCPP FROM 1977-87,
Wyoming Univ., Laramie. Dept. of Atmospheric Science.
For primary bibliographic entry see Field 3B.
W88-05705

## 2C. Snow, Ice, and Frost

SOIL HEAT FLUX IN PERMAFROST: CHARACTERISTICS AND ACCURACY OF MEASUREMENT,
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
D. H. Halliwell, and W. R. Rouse.
Journal of Climatology JOUCD2, Vol. 7, No. 6, p 571-584, November-December, 1987. 8 fig, 2 tab, 11 ref.

Descriptors: *Heat transfer, *Permafrost, *Soil physical properties, *Peat, Freezing, Temperature, Soil temperature, Enthalpy, Energy, Manitoba, Soil types, Error analysis, Mathematical studies, Mathematical equations.

Soil heat flux plates are a standard method of measuring soil heat flux in energy balance and related studies. Recent work has suggested that heat flux plates significantly underestimate the true flux value in permafrost terrain. The calorimetric method of soil heat flux determination was used to assess the reliability of heat flux plate data using data from two sites near Churchill, Manitoba, collected over two summer thaw periods. The heat flux plates underestimate the surface heat flux in organic permafrost terrain by about 50%. The most likely cause of the error appears to be a combination of poor thermal contact between the plate and the peat soil, and possible vapor transport through the porous material. Recommendations are made to reduce errors in field determinations of soil heat flux. The calorimetric calculations indicate that the largest portion of the soil heat flux is stored as latent heat in the thawing of ground ice. The flux at 1.5 m depth constitutes a significant portion of the surface flux. The smallest component of the surface flux is the portion stored as sensible heat in the layer between the surface and the 1.5 m depth. Overall, the soil heat flux represents a high fraction (from 16 to 18%) of the net all-wave radiation available at the surface. (Author's abstract)
W88-05310

REAL-TIME SIMULATION MODEL FOR THE MONONGAHELA RIVER BASIN,
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 2A.
W88-05418

MODELING SOLUTE SEGREGATION DURING FREEZING OF PEATLAND WATERS,
Michigan Univ., Ann Arbor. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W88-05436

GLACIO-FLUVIAL SEDIMENT TRANSFER: AN ALPINE PERSPECTIVE.
For primary bibliographic entry see Field 2J.
W88-05784

ALPINE SEDIMENT SYSTEM: A CONTEXT FOR GLACIO-FLUVIAL PROCESSES,
Southampton Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-05785

GEOCRYOLOGICAL INPUTS TO THE ALPINE SEDIMENT SYSTEM,
Southampton Univ. (England). Dept. of Geography.
M. J. Clark.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 33-58, 5 fig, 4 tab, 88 ref.

Descriptors: *Weathering, *Erosion, *Glaciology, *Geocryology, *Cryology, *Sedimentation, *Alpine regions, Hydrologic models, Sediment transport, Snow, Permafrost, Slope stability, Model studies.

The alpine sediment system provides a broad cryogenic framework within which it is possible to assess both the role and linkage of the glacio-fluvial sediment transfer subsystem. Models of alpine sediment transfer have often been little more than structured inventories of process, but a growing interest in process integration has produced several contributions which have systems characteristics. While a comprehensive review of no-glacial sediment processes is inappropriate, it is helpful to establish the significance of geocryological processes in three contexts, alpine permafrost, the role of snow and the slope processes themselves, glacial-fluvial system, and at the same time indicates that current research is achieving progress both through a growing consensus and through a new willingness to face contention and accept change in traditional views. (See also W88-05784) (Author's abstract)
W88-05786

SEDIMENT TRANSFER PROCESSES IN ALPINE GLACIER BASINS,
Worcester Coll., Oxford (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-05787

ENGLACIAL AND SUPRAGLACIAL SEDIMENT: TRANSPORT AND DEPOSITION,
Southampton Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-05789

SUBGLACIAL SEDIMENT SYSTEM,
Universite Libre de Bruxelles (Belgium). Lab. de Geomorphologie.
For primary bibliographic entry see Field 2J.
W88-05790

MORAINE SEDIMENT BUDGETS,
Southampton Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-05791

GLACIAL SEDIMENT SYSTEM: AN ALPINE PERSPECTIVE,
Southampton Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-05792

GLACIAL HYDROLOGY,
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
H. Rothlisberger, and H. Lang.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 207-284, 29 fig, 9 tab, 150 ref.

Descriptors: *Glaciers, *Hydrologic properties, *Englacial drainage, *Subglacial drainage, *Glaciohydrology, Runoff, Snowmelt, Climates, Seasonal variation, Flow profiles, Flow rate, Ice, Gla-

cial lakes, Mass balance, Hydrologic budget, Pipe flow.

An overview of the hydro-climatic conditions of glaciers and their effects on the runoff is given in the first part of this chapter. The meaning of mass balance and water balance in glacierized areas is explained and methods for their determination are described. The main factors influencing accumulation and ablation are considered and their relative importance is assessed. The characteristics of glacier runoff (diurnal and annual cycles, aperiodic fluctuations related to weather or hydroglaciological processes) are outlined and long-term effects of climatic variations are discussed. The second part considers the englacial and subglacial drainage of meltwater. The physical background of various aspects of fast water flow in ice-walled pipes and slow seepage through permeable ice is described, and the consequences for discharge patterns and the location of englacial and subglacial conduits are discussed. Reciprocal effects of glacier sliding and water drainage are shown to explain various observations including water storage during glacier uplift. The problems of glacier-dammed lakes and the methods of investigating intra- and subglacial drainage are also briefly considered. (See also W88-05784) (Author's abstract)
W88-05793

**SOLUTES,**
Universite Libre de Bruxelles (Belgium). Lab. de Geomorphologie.
R. A. Souchez, and M. M. Lemmens.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 285-303, 3 fig, 2 tab, 36 ref.

Descriptors: *Glaciohydrology, *Water chemistry, *Solute transport, *Glaciers, *Chemical analysis, Alpine regions, Snowmelt, Carbon dioxide, Water temperature, Atmospheric pressure, Solutes, Catchment areas, Elevation.

The different mechanisms responsible for the solute content of alpine glacial meltwaters are analyzed and discussed. The paper begins by considering the characteristics of the alpine glacier environment which may influence the water chemistry. These include: altitude; CO2 availability; atmospheric pressure; water temperature of meltwater; and erosion. This is followed by an evaluation of atmospheric inputs to alpine drainage basins. The central theme of the paper is the study of the mechanisms acting on the solute content of glacial meltwaters either englacially or subglacially. This discussion is concluded with an assessment of chemical activity in alpine glacierized drainage basins in comparison with drainage basins in other environments. (See also W88-05784) (Lantz-PTT)
W88-05794

**SUSPENDED SEDIMENT,**
Southampton Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-05795

**ELECTRICAL CONDUCTIVITY,**
Worcester Coll., Oxford (England). Dept. of Geography.
For primary bibliographic entry see Field 7B.
W88-05797

**FLUVIAL SEDIMENT YIELD FROM ALPINE, GLACIERIZED CATCHMENTS,**
Southampton Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-05798

**PROGLACIAL CHANNEL PROCESSES,**
Worcester Coll., Oxford (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-05799

**GLACIAL MELTWATER STREAMS, HYDROLOGY AND SEDIMENT TRANSPORT: THE CASE OF THE GRANDE DIXENCE HYDROELECTRICITY SCHEME,**
Grande Dixence Societe Anonyme, Sion (Switzerland).
For primary bibliographic entry see Field 2E.
W88-05800

**GLACIO-FLUVIAL SEDIMENT SYSTEM: APPLICATIONS AND IMPLICATIONS,**
Southampton Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-05801

## 2D. Evaporation and Transpiration

**EVAPOTRANSPIRATION ESTIMATES IN EXTREMELY ARID AREAS,**
Ministry of Agriculture and Water, Riyadh (Saudi Arabia).
S. A. Al-Sha'lan, and A. M. A. Salih.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 565-574, November 1987. 5 fig, 3 tab, 10 ref.

Descriptors: *Arid lands, *Saudi Arabia, *Evapotranspiration, *Irrigation management, *Water resources management, *Model studies, Performance evaluation, Estimating, Irrigation, Arid climates.

Consumptive use or evapotranspiration is an important element for estimating irrigation water requirements and in water resources management, especially under arid conditions where fresh water is a limited resource. In this study, 23 empirical methods have been selected from the literature and used for estimating consumptive use (or evapotranspiration) under the extremely arid conditions of central Saudi Arabia using the corresponding climatic data collected from the Hofuf station. The results from these methods have been evaluated with reference to actual measurements performed in the same area in two separate 12-mo periods and then ranked according to five different rating criteria. The top six ranked methods obtained for the average as well as for Salih and Sendil's ratings are ranked in the following order of merit: Jensen-Haise, class A pan, Ivanov, adjusted class A pan, Behnke-Maxey, and Stephens-Stewart. (Author's abstract)
W88-05142

**SPRINKLER EVAPORATION LOSS EQUATION,**
Oregon State Univ., Corvallis. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W88-05148

**EVALUATION OF THE IMPACT OF TWO COMMON AQUATIC PLANTS, TYPHA LATIFOLIA AND EICHORNIA CRASSIPES, ON WATER LOSS FROM FRESHWATER PONDS,**
Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.
R. L. Snyder.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8606192. Ph.D Dissertation, 1985. 83 p, 6 fig, 11 tab, 66 ref, append.

Descriptors: *Evapotranspiration control, *Aquatic plants, *Plant growth, *Water loss, *Ponds, Hydrologic budget, Mathematical equations, Meteorological data collection, Water quality.

Descriptive data for plants were associated with evapotranspiration rates and a method for predicting evapotranspiration was developed to evaluate the impact of the aquatic plants Typha latifolia (cattail) and Eichorina crassipes (Water hyacinth) on water loss from freshwater ponds. Plant leaf area, height above water, standing crop, and density were induced by maintaining two fertilization regimes in tanks containing cattail and three regimes in tanks containing water hyacinth. Although the research involved the study of evapotranspiration in artificial ponds (tanks), the water-loss ratios demonstrated that the ponds were interacting with the environment similarly to actual small farm ponds. This finding indicates that the cattail and water hyacinth have a negative impact on the pond water balance by causing monthly losses of around twice that of a plant-free pond over a 6-month growing season. Special efforts should be made by small pond owners to eliminate aquatic weeds in ponds where water input is inadequate to maintain desirable levels through the summer and fall. (Cremmins-AEPCO)
W88-05202

**IMPACT OF RAPID URBANIZATION ON PAN EVAPORATION IN PHOENIX, ARIZONA,**
Arizona State Univ., Tempe. Dept. of Geography.
For primary bibliographic entry see Field 4C.
W88-05312

**EFFECT OF URBANIZATION ON SOME CHARACTERISTICS OF RELATIVE HUMIDITY IN IBADAN,**
Ilorin Univ. (Nigeria). Dept. of Geography.
For primary bibliographic entry see Field 4C.
W88-05313

**BASINWIDE WATER-BALANCE MODELING WITH EMPHASIS ON SPATIAL DISTRIBUTION OF GROUND WATER RECHARGE,**
Kansas State Geological Survey, Lawrence.
For primary bibliographic entry see Field 4B.
W88-05401

**WATER BALANCE OF PACIFIC ATOLLS,**
Hawaii Univ., Honolulu. Dept. of Geography.
D. Nullet.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1125-1132, December 1987. 7 fig, 1 tab, 34 ref, append.

Descriptors: *Hydrologic budget, *Atolls, *Evapotranspiration, Recharge, Pacific Ocean, Vegetation, Water stress, Clouds, Precipitation, Tropical regions, Mathematical equations, Estimation, Model studies, Hydrologic models, Soil water.

An estimate of water balance components for Pacific atolls under average climatological conditions is presented. Figures show annual potential evapotranspiration, annual recharge for rain-fed and aquifer-fed vegetated areas, and the number of months that potential evapotranspiration exceeds actual evapotranspiration (indicating water stress) under average conditions. The method relies on the assumption that small islands have minimal influence on cloudiness and precipitation. The potential evapotranspiration is computed using the equilibrium evaporation concept, and estimates of monthly soil water storage and recharge follow Thornwaite's bookkeeping method. Gradients in potential evapotranspiration run primarily north-south, though for the equatorial zone potential evapotranspiration declines from east to west, opposing the trend in rainfall. Recharge estimates range from 250 mm in the central Tuamotu Archipelago and zero in eastern Kiribati to over 2000 mm yr in the southern Caroline Islands (U.S. Trust Territory) and Solomon Islands. Recharge under actual conditions (dependent on high rainfall years) is not reflected in a water balance that depends on climatic averages, and, therefore, the model yields zero recharge for areas with < 1,000 mm annual rainfall. (Wood-PTT)
W88-05416

**USE OF STREAMFLOW INCREASES FROM VEGETATION MANAGEMENT IN THE VERDE RIVER BASIN,**
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
For primary bibliographic entry see Field 3B.
W88-05419

**FOREST EVAPORATION AND METEROLOGICAL DATA: A TEST OF A COMPLEMENTARY THEORY ADVECTION-ARIDITY APPROACH,**
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Forest Research.
G. F. Byrne, F. X. Dunin, and P. J. Diggle.
Water Resources Research WRERAO, Vol. 24, No. 1, p 30-34, January 1988. 5 fig, 1 tab, 28 ref.

Descriptors: *Evaporation, *Forests, *Meteorological data, *Evaporation rate, Forest evaporation, Mathematical equations, Mathematical studies, Field tests, Lysimeters, Evaporation area, Regional evaporation, Correlation analysis, Advection, Advection-Aridity method.

A relationship between daily forest evaporation and meteorological screen data, based on an extension of a previous complementary theory approach to pasture evaporation, is proposed. The resulting formulation is tested against 800 days of a 5-year lysimeter record for a eucalypt forest and appears to offer an alternative and plausible formulation of the relationship between the meteorological data and regional evaporation. (Author's abstract)
W88-05527

**INTERANNUAL VARIABILITY OF THE HYDROLYTIC CHARACTERISTICS AND PRODUCTIVITY OF THE PHYTOPLANKTON IN LARGE WATER BODIES OF THE NORTHWEST USSR,**
Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.
For primary bibliographic entry see Field 2H.
W88-05577

**INFLUENCE OF DROUGHT STRESS ON 14-CO2 FIXATION AND ASSIMILATION, AND DISTRIBUTION OF PHOTOSYNTHATES IN WHEAT SEEDLINGS (INFLUENCE DU DEFICIT HYDRIQUE SUR LA FIXATION, L'ASSIMILATION DE 14CO2 ET LA DISTRIBUTION DES PHOTOSYNTHETATS CHEZ JEUNES PLANTES DE BLES),**
Centre National de la Recherche Scientifique, Orsay (France).
A. Talouizte, I. Florenza, M. Rafales, M. Champigny, and A. Moyse.
Comptes Rendus de l'Academie des Sciences (Series 3) CHDDAT, Vol. 305, No. 20, December 1987. 2 tab, 21 ref.

Descriptors: *Wheat, *Drought, *Metabolism, *Enzymes, *Photosynthesis, Osmosis, Ribulose-biphosphate carboxylase-oxygenase, Carbon dioxide fixation, Nitrogen stress, Leaves, Water stress, Water potentials, Plant physiology, Plant growth.

Drought stress was induced by the addition of polyethylene glycol 400(PEG) at concentrations of 12.5% (leaf water potential maintained below the solution water potential), 20 and 35% (leaf water potential higher than the solution water potential) into the nutrient solution of three-week old wheat seedlings. The moderate water deficit slightly enhanced the rate of carbon-14 labeled CO2 fixation, stimulated the synthesis of sucrose, and did not affect the export of photoassimilates from the source leaf to the sink organs. In contrast, the rate of CO2 fixation was lowered under severe water deficits. The highest incorporation of labeled CO2 into serine and glycine which contrasted with the lowest incorporation into sucrose was interpreted as indicating that the oxygenase activity was less affected by the treatment than the carboxylase activity of the ribulose-biphosphate carboxylase-oxygenase. Under the severe water deficit the export of photoassimilates from the source leaf to the sink organs was enhanced in seedlings on nitrate. The effect of drought was therefore similar to that of nitrogen stress. The stimulation of photoassimilate export in seedlings whose growth was inhibited by drought suggests the existence of a demand for assimilates, distinct from the demand for sustaining growth. It is suggested that this demand might be related to the need for the plant to maintain its osmotic equilibrium. (Author's abstract)
W88-05578

## 2E. Streamflow and Runoff

**FLOOD FREQUENCY ESTIMATES IN SOUTHEASTERN ARIZONA,**
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
For primary bibliographic entry see Field 4A.
W88-05136

**ANALYTICAL SOLUTION OF SIMPLIFIED SURGE FLOW EQUATIONS,**
Technische Univ. Muenchen (Germany, F.R.). Dept. of Waterworks and Water Management.
G. H. Schmitz, and G. J. Seus.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 605-610, November 1987. 7 ref, append.

Descriptors: *Model studies, *Hydrodynamics, *Waves, *Surge flow, *Mathematical equations, *Flow velocity, Unsteady flow, Channels, Equations, Slope, Resistance, Flow.

Several approaches with varying degrees of sophistication have been suggested for the computation of a surge running down a dry channel. The different levels of approximations range from numerical solutions of the one-dimensional differential equations of shallow water flow to rather simple flow formulas. At the end of the last century, Ritter gave a solution of the Saint-Venant equations for flooding from an instantaneous dambreak in a prismatic channel of rectangular crosssection, assuming both zero bottom slope and resistance. This solution has been extended to prismatic channels with varying width. The essence of the solution, proposed by Witham lies in the postulates that all resistance effects are restricted to the wave tip, where water velocity is the same and equal to wave-propagation speed. Neglecting all minor terms in the equation of motion, the bottom slope S sub O as well as the acceleration terms, yields an approximate differential equation for the water surface profile, which can be integrated analytically. This work extends the Witham solution by additionally taking into account the continuity equation without employing the assumption of uniform flow velocity along the wave. (Alexander-PTT)
W88-05146

**HYDROLOGIC STUDY OF LARGE BASIN IN EASTERN WYOMING,**
HDR Infrastructure, Omaha, NE.
R. Graham.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 114, No. 1, p 52-65, January 1988. 10 fig, 2 tab, 20 ref.

Descriptors: *Flood frequency, *Model studies, *Wyoming, *Hydrology, *Dams, *Flood basins, Storms, Basins, Mathematical equations, Flood peak, Gages, Mathematical models.

A case study of the Horse Creek basin in eastern Wyoming involved calculating the 100-year frequency and the probable maximum flood at several potential dam locations using a deterministic hydrologic model. The basin drains 1,560 sq mi. The basin has a long-record gage near the point of interest, but the record is suspect due to irrigation diversion and return flows. Therefore, a flood flow frequency analysis from a hydrologically similar basin was performed. This included peak discharge and high volume-duration-frequency derivations. The model allows centering of a storm over a critical portion of the basin, with residual rainfall over the remainder. The study concludes that generation of rare-event and probable-maximum-flood (PMF) design discharges at gaged locations requires careful analysis of the basin and gaged data. This includes review of hydrologically similar basins to allow generation of appropriate statistical parameters for calibration of a deterministic model. (Author's abstract)
W88-05152

**FITTING MINIMA OF FLOWS VIA MAXIMUM LIKELIHOOD,**
Wright State Univ., Dayton, OH. Dept. of Geological Science.
H. A. Loaiciga, and M. A. Marino.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 114, No. 1, p 78-90, January 1988. 3 fig, 2 tab, 9 ref. Water Resources Center Project UCAL-WRC-W-634.

Descriptors: *Streamflow forecasting, *Stream discharge, *Statistical methods, *Model studies, *Low flow, *Flow rates, Mathematical equations, Streams, Distribution, Water supply development, Estimating, Prediction.

A statistical method for deriving frequency distribution functions of minima of streamflows is presented. An innovative feature of the proposed methodology is that it does not require the specification of a parent distribution for streamflows, i.e., it is distribution free. The only assumption necessary is that the realizations of streamflows be independent, identically distributed random variables. The validity of this assumption is established with a nonparametric test. The main use of the methodology developed is in estimating small quantiles of the flow distribution for water supply planning and low-flow investigations. An example is included to illustrate the applicability of the approach, using a record of annual flows. (Author's abstract)
W88-05154

**DISTRIBUTED DYNAMIC WATERSHED MODEL,**
Texas A and M Univ., College Station. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W88-05207

**ANNUAL FLOW STATISTICS AND DROUGHT CHARACTERISTIC FOR GAGED AND UNGAGED STREAMS IN IDAHO,**
Idaho Univ., Moscow. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W88-05236

**FIELD STUDIES ON THE BEHAVIOUR OF ORGANIC MICROPOLLUTANTS DURING INFILTRATION OF RIVER WATER TO GROUND WATER,**
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5B.
W88-05251

**RESEARCH ON THE PHYSIOLOGICAL BASIS OF POPULATION DYNAMICS IN RELATION TO ECOTOXICOLOGY,**
Hoofdgroep Maatschappelijke Technologie TNO, Delft (Netherlands).
For primary bibliographic entry see Field 5C.
W88-05294

**IMPACT OF WATERSHED URBANIZATION ON STREAM INSECT COMMUNITIES,**
George Mason Univ., Fairfax, VA. Dept. of Biology.
For primary bibliographic entry see Field 4C.
W88-05406

**COMPARISON OF METHODS FOR ESTIMATING LOW FLOW CHARACTERISTICS OF STREAMS,**
Geological Survey, Reston, VA.
G. D. Tasker.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1077-1083, December 1987. 5 fig, 1 tab, 20 ref.

Descriptors: *Stream discharge, *Estimating equations, *Comparison studies, *Data interpretation, Estimating, Low-flow properties, Streams, Monte Carlo method, Bootstrap method, Log-Pearson III method, Weibull method, Box-Cox transformation method, Log-Boughton method, Mathematical

equations, Comparison studies, Mathematical studies.

Four methods for estimating the 7-day, 10-year and 7-day, 20-year low flows for streams were compared by the bootstrap method. The bootstrap method is a Monte Carlo technique in which random samples are drawn from an unspecified sampling distribution defined from observed data. The nonparametric nature of the bootstrap makes it suitable for comparing methods based on a flow series for which the true distribution is unknown. Results show that the two methods based on hypothetical distributions (Log-Pearson III and Weibull) had lower mean square errors than did the Box-Cox transformation method or the Log-Boughton method which is based on a fit of plotting positions. (Author's abstract)
W88-05410

**CHANNEL DISCHARGE MEASUREMENT BY THERMODILUTION,**
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W88-05414

**PATTERNS OF WATERSHED MONTHLY RUNOFF,**
For primary bibliographic entry see Field 2A.
W88-05417

**LIMITATIONS OF CONCEPTS USED TO DETERMINE INSTREAM FLOW REQUIREMENTS FOR HABITAT MAINTENANCE,**
Nebraska Univ., Lincoln. Inst. of Agriculture and Natural Resources.
A. S. Bleed.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1173-1178, December 1987. 1 fig, 58 ref. U.S. Department of the Interior/Geological Survey Grant 87-287-522-15.

Descriptors: *Instream flow requirements, *River flow, *Habitat maintenance, *Model studies, *Wildlife habitats, Flow requirements, Comparison studies, Rivers, Platte River, Nebraska, Channel morphology, Habitats, Model assumptions, Decision making.

Most rivers are not freely flowing but are highly regulated to meet both human and wildlife needs. Several models allow the determination of instream flows that are needed to meet wildlife demands. However, these models are based on assumptions that limit their applicability to certain types of rivers. They are valid when applied to alluvial channels that are in equilibrium with their flows. While these limitations do not preclude the use of the models on other types of rivers, like the Platte River in Nebraska which is not in equilibrium, their limitations should be considered and accommodated by those making instream flow planning and management decisions. Other factors affecting channel morphology and its associated wildlife habitat, such as threshold values and vegetation are not adequately considered by current concepts. If rivers are to be managed to provide wildlife habitat, these factors must be addressed. More interdisciplinary research is needed on the role of erosion and vegetation in the shaping of river channels. (Author's abstract)
W88-05421

**PARAMETER ESTIMATION FOR TPLN DISTRIBUTION FOR FLOOD FREQUENCY ANALYSIS,**
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
V. P. Singh, and K. Singh.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1185-1191, December 1987. 2 fig, 3 tab, 12 ref.

Descriptors: *Flood forecasting, *Flood frequency, *Parameter estimation, *Flood estimating, Distribution patterns, Mathematical equations, Floods, Entropy, Frequency analysis, Comparison studies, Mathematical studies, Flow discharge, Rivers, Discharge frequency, Principle of maximum entropy, Surface water, Hydrology, Statistics, Error analysis.

The principle of maximum entropy (POME) was used to derive an alternative method for parameter estimation for the three parameter lognormal (TPLN) distribution. Six sets of annual peak discharge data were used to evaluate this method and compare it with the methods of moments (MOM) and maximum likelihood estimation (MLE). It is concluded that POME offers an acceptable alternative method for estimating parameters of the TPLN distribution and that the parameter estimates yield by POME were as good as those by MOM and MLE. The relative mean error and the relative absolute error for six selected rivers (the Comite and Amite in Louisiana, the St. Mary in Nova Scotia, and the St. John, the Allagash, and the Fish in Maine) were computed by all three methods and were found to be about equivalent. (Wood-PTT)
W88-05423

**BED LOAD TRANSPORT REGIME OF A SMALL FOREST STREAM,**
Forest Service, Ogden, UT. Intermountain Research Station.
For primary bibliographic entry see Field 2J.
W88-05435

**BED LOAD TRANSPORT FLUCTUATIONS IN A GRAVEL BED LABORATORY CHANNEL,**
Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences.
For primary bibliographic entry see Field 2J.
W88-05439

**STUDY OF RIVER REAERATION AT DIFFERENT FLOW RATES,**
Ministry of Works and Development, Hamilton (New Zealand). Water Quality Centre.
For primary bibliographic entry see Field 5B.
W88-05512

**WATER JET-INDUCED CIRCULATION IN CHANNEL: III. COMPARISON WITH AERATION,**
Shell Development Co., Houston, TX.
For primary bibliographic entry see Field 5G.
W88-05516

**EFFECTS OF STREAMFLOW VARIATION ON CRITICAL WATER QUALITY FOR MULTIPLE DISCHARGES OF DECAYING POLLUTANTS,**
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W88-05524

**FLOW PROCESSES IN A CURVED ALLUVIAL CHANNEL,**
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
A. J. Odgaard, and M. A. Bergs.
Water Resources Research WRERAO, Vol. 24, No. 1, p 45-56, January 1988. 15 fig, 2 tab, 27 ref. NSF Grant MSM-8308470.

Descriptors: *Channel flow, *Sediment transport, *Alluvial channels, *Flow profiles, Channels, Curved channels, Flow, Momentum equation, Momentum balance, Flow measurement, Flow acceleration, Flow rates, Model evaluation, Mathematical equations.

Dynamic features of the flow in a 180 degree constant-radius, recirculating laboratory channel were studied. The width-depth ratio and radius-width ratio of the channel were 16 and 5.4, respectively, and the sediment was sand with median grain diameter and geometric standard deviation of 0.3 millimeters and 1.45, respectively. The particle densimetric Froude number was 6.5. Individual components of the momentum equation were measured, and their relative effects on the momentum balance was evaluated. Flow accelerations, notably downstream acceleration of the downstream and cross-stream velocity components, induced as a result of change in channel curvature at the entrance to the bend had a significant effect on the flow processes in this bend. The cross-stream velocity gradients were relatively insignificant. The curvature change affects the flow and bed topography in a manner similar to that in which a driving force affects an underdamped oscillating system. The findings may be used for an evaluation of available bend flow models. (Author's abstract)
W88-05529

**AQUATIC WEED PROBLEMS IN A HYDROELECTRIC RIVER: THE RIVER OTRA, NORWAY,**
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 4A.
W88-05551

**CHANGES IN THE PHYSICO-CHEMISTRY AND BENTHIC INVERTEBRATES OF THE GREAT FISH RIVER, SOUTH AFRICA, FOLLOWING AN INTERBASIN TRANSFER OF WATER,**
For primary bibliographic entry see Field 4A.
W88-05552

**REAL-TIME FLOOD MANAGEMENT MODEL FOR HIGHLAND LAKE SYSTEM,**
Texas Univ., Austin. Dept. of Civil Engineering.
O. Unver, L. W. Mays, and K. Lansey.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 5, p 620-638, September, 1987. 11 fig, 3 tab, 14 ref.

Descriptors: *Flood forecasting, *Flood plain management, *Colorado River Basin, *Computer models, *Highland Lake System, *Expert systems, Forecasting, Dams, Computers, Model studies, Basins, River basins, Catchment areas, Protection, Flood protection, Flooding, Rainfall-runoff relationships, Precipitation, Reservoirs, Rainfall, Flow, River flow, Water level.

A real-time flood management (forecasting) model was developed for flood operation of the Lower Colorado River-Highland Lake System in Texas. This model combines techniques for one-dimensional unsteady flow routing, rainfall-runoff modeling, graphical display capability, and interactive software capability. Unsteady flow routing uses the United States National Weather Service DWOPER model. The model allows for specification of alternative future precipitation and river-level scenarios and operational controls in addition to real-time river levels, reservoir levels, and rainfall. The real-time management model and optimization model, coupled with other extensions, represent the main structure of a possible expert systems application to real-time reservoir operation that simulates the behavior of the system manager, given the physical system, data collection capabilities, feedback from past operations, and the software available. (Author's abstract)
W88-05638

**BEDLOAD,**
Oxford Univ. (England). Geography School.
For primary bibliographic entry see Field 2J.
W88-05796

**GLACIAL MELTWATER STREAMS, HYDROLOGY AND SEDIMENT TRANSPORT: THE CASE OF THE GRANDE DIXENCE HYDROELECTRICITY SCHEME,**
Grande Dixence Societe Anonyme, Sion (Switzerland).
A. Bezinge.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 473-498, 18 fig, 4 tab, 21 ref.

Descriptors: *Glacial streams, *Glaciohydrology, *Floods, *Runoff, *Sediment transport, *Grande Dixence Hydroelectric Scheme, Snowmelt, Alpine regions, Topography, Glaciers, Catchment areas,

Sediment load, Bed load, Suspended sediments, Runoff, Switzerland, Storms.

Since 1948, the Grande Dixence company has been studying many aspects of the glacial meltwater streams that it uses intensively in the production of hydroelectricity. The Grande Dixence hydroelectric scheme utilizes meltwaters from the alpine valleys of St. Nicolas (Mattertal) and Herens, Valais, Switzerland. The catchment area of the scheme consists of 35 drainage basins ranging in area from 1 to 80 sq km. Each basin has its own topographic, microclimatic and glacial characteristics. The best known and the most regular meltwater outburst within the Grande Dixence catchment area is the release of waters from the Gornersee, a lake which develops annually at the junction of the Gorner and Grenz glaciers (altitude 2600 m). The hydrology of alpine watersheds is very varied and is not regular from year to year. Moreover, long-term hydrology is influenced by changes in glacier area. For example, the Valais glaciers decreased by about 160 sq km in area between 1915 and 1958. It has been calculated, that under similar weather conditions, the summer discharge of the Rhone is 700 million cu m lower as a result of this decrease in glacier area. This phenomenon has also occurred in the runoff of the basins analyzed in this study. It is noteworthy that the annual runoff of a glacier basin corresponds to about 1-2% of the volume of ice stored. Some glacierized basins, such as the Arb, Trift, Bis and Festi, yield very little suspended sediment or bedload. Only localized storms, as occur in the Rosses or Vouasson (schists) basins, are able to release debris flows or mudflows of thousands of cubic meters. A similar phenomenon is produced by meltwater outbursts, as has been observed in the Kin basin, where the release of 100,000 cu m of water (peak discharge, 4-5 cu m/sec) transported 70,000-80,000 cu m of debris onto the Visp-Zermatt road and railway line. The discharge and sediment was delivered from source areas at an altitude of between 1400 and 2800 m. Catastrophic phenomena occur, like the storm in October 1977 over the Ferpecle basin, which transported a sediment load equivalent to 4-5 yrs of normal sediment yield and which filled up a natural 20,000 cu m lake. It is highly probable that all the large debris cones, which are typical of alpine valleys, originate from extreme phenomena such as violent storms and intense melting of snow and ice. (See also W88-05784) (Lantz-PTT)
W88-05800

## 2F. Groundwater

**UNDERSTANDING GROUNDWATER MONITORING,**
For primary bibliographic entry see Field 7B.
W88-05130

**GROUNDWATER/LAKE DYNAMICS AND CHEMICAL EVOLUTION IN A SANDY SILICATE AQUIFER IN NORTHERN WISCONSIN,**
Wisconsin Univ., Madison. Dept. of Geology.
For primary bibliographic entry see Field 2H.
W88-05203

**COASTAL-A DISTRIBUTED HYDROLOGIC SIMULATION MODEL FOR LOWER COASTAL PLAIN WATERSHEDS IN GEORGIA,**
Georgia Univ., Athens. Graduate School.
For primary bibliographic entry see Field 2A.
W88-05204

**REMOVAL OF CHLORINATED SOLVENTS FROM WATER BY AIR STRIPPING,**
Institut National des Sciences Appliquees, Toulouse (France). Dept. 'Genie des Procedes Industriels'.
For primary bibliographic entry see Field 5F.
W88-05246

**FIELD STUDIES ON THE BEHAVIOUR OF ORGANIC MICROPOLLUTANTS DURING INFILTRATION OF RIVER WATER TO GROUND WATER,**
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5B.
W88-05251

**GROUNDWATER VULNERABILITY MAPS,**
National Water Supply Co., Brussels (Belgium).
For primary bibliographic entry see Field 5B.
W88-05283

**GROUNDWATER, IRON AND MANGANESE: AN UNWELCOME TRIO,**
HKM Associates, Billings, MT.
For primary bibliographic entry see Field 5F.
W88-05350

**RAPID WATER TABLE RESPONSES TO RAINFALL IN A NORTHERN PEATLAND ECOSYSTEM,**
George Mason Univ., Fairfax, VA. Dept. of Biology.
For primary bibliographic entry see Field 2A.
W88-05402

**NONLINEAR SOLUTIONS OF THE BOUSSINESQ EQUATION AND COMPARISONS WITH FIELD OBSERVATIONS,**
Technical Univ. of Lodz (Poland).
J. K. Leznicki, and G. P. Korfiatis.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1085-1089, December 1987. 3 fig, 11 ref.

Descriptors: *Groundwater movement, *Boussinesq equation, *Hydrologic models, *Model studies, Finite difference methods, Prediction, Poland, Drawdown, Mine drainage, Pumping, Aquifers, Geohydrology, Differential equations, Mathematical equations, Mathematical studies.

Two models based on variations of the one dimensional Boussinesq equation were formulated by treating each of the two linearities appearing in the equation separately, and the resulting equations were solved by implicit finite difference techniques. The models were used to predict drawdowns created from a large scale pumping at an open coal mine pit dewatering project in Poland. The predictions were in good agreement with data collected over a period of seven years. (Author's abstract)
W88-05411

**REGIONAL MANAGEMENT OF DEPLETED AQUIFERS,**
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
For primary bibliographic entry see Field 4B.
W88-05422

**MATHEMATICAL MODELING OF SOLUTE TRANSPORT IN THE SUBSURFACE,**
Battelle Memorial Inst., Columbus, OH. Environmental and Health Sciences Section.
For primary bibliographic entry see Field 5B.
W88-05425

**AIR STRIPPING TEASES VOCS FROM GROUNDWATER,**
Hydro Group, Inc., Linden, NJ. Environmental Products Div.
For primary bibliographic entry see Field 5D.
W88-05429

**GEOCHEMISTRY OF GROUNDWATER IN TERTIARY AND CRETACEOUS SEDIMENTS OF THE SOUTHEASTERN COASTAL PLAIN IN EASTERN GEORGIA, SOUTH CAROLINA, AND SOUTHEASTERN NORTH CAROLINA,**
Geological Survey, Nashville, TN.
For primary bibliographic entry see Field 2K.
W88-05443

**TOXICOLOGICAL STUDIES OF CHEMICAL MIXTURES OF ENVIRONMENTAL CONCERN AT THE NATIONAL TOXICOLOGY PROGRAM: HEALTH EFFECTS OF GROUNDWATER CONTAMINATION,**
National Toxicology Program, Research Triangle Park, NC.
For primary bibliographic entry see Field 5C.
W88-05498

**MULTICOMPONENT EXCHANGE AND SUBSURFACE SOLUTE TRANSPORT: CHARACTERISTICS, COHERENCE, AND THE RIEMANN PROBLEM,**
Texas Univ. at Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W88-05530

**MEASUREMENTS OF CESIUM AND STRONTIUM DIFFUSION IN BIOTITE GNEISS,**
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W88-05532

**ANALYTICAL MODELS OF SLUG TESTS,**
Lawrence Berkeley Lab., CA. Earth Sciences Div.
K. Karasaki, J. C. S. Long, and P. A. Witherspoon.
Water Resources Research WRERAO, Vol. 24, No. 1, p 115-126, January 1988. 14 fig, 19 ref, 2 append. DOE Contract DE-AC03-76-SF00098.

Descriptors: *Slug tests, *Pumping tests, *Aquifer testings, *Groundwater movement, *Data interpretation, *Mathematical studies, *Mathematical models, Groundwater, Model studies, Mathematical equations, Geologic fractures, Rocks, Flow characteristics, Groundwater, Test wells, Porous media, Homogeneity, Heterogeneity.

Slug tests, originally developed to estimate flow parameters of shallow aquifers approximated by homogeneous porous media and also widely used to estimate the flow parameters of heterogeneous systems, are inexpensive, easy to perform and require a relatively short time to complete. However, available analysis methods were limited to a few ideal cases. Therefore, solutions to various models of slug tests are developed that can be applied to the analysis of results of the tests where existing solutions are inadequate. Various geometries that may be encountered in heterogeneous systems, such as fractured rocks, are considered. Solutions are presented for linear flow, radial flow with boundaries, two layer, and concentric composite models with different flow geometries between the inner and outer region. Solutions are obtained in Laplace space and numerically inverted to real space. Type curves are presented for each solution. Analyses of the type curves and derivative response curves reveal that many curves have unique shapes only for certain combination of flow parameters and the distance. Other sets of type curves are similar in shape, although log-log plots and derivative plots may emphasize some features that may not be apparent in semilog plots. These results show that slug tests suffer problems of nonuniqueness to greater extent than other well tests. (Wood-PTT)
W88-05536

**DISSOLVED OXYGEN SYSTEMATICS IN THE TUCSON BASIN AQUIFER,**
Arizona Univ., Tucson. Dept. of Geosciences.
S. Rose, and A. Long.
Water Resources Research WRERAO, Vol. 24, No. 1, p 127-136, January 1988. 6 fig, 1 tab, 33 ref.

Descriptors: *Geochemistry, *Dissolved Oxygen, *Distribution patterns, *Groundwater, *Aquifers, Tucson Basin, Saturation, Water table, Oxidation, Detritus, Decomposing organic matter, Mathematical equations, Phreatophytes, Vadose water.

Dissolved oxygen (DO) is ubiquitous in Tucson basin groundwater; however, its distribution is systematic and distinct facies are apparent. Dissolved oxygen concentrations approach a minimum of 15% of the saturation limit in a chemically imma-

ture recharge facies and then rapidly increase downgradient. Groundwater throughout most of the central basin remains nearly saturated with dissolved oxygen for thousands of years during the course of its chemical evolution. DO concentrations were lowest where the water table was the highest, indicative of the oxidation of phreatophyte detritus. Transverse dispersive influx of dissolved oxygen from the vadose atmosphere into the shallow phreatic zone represents an inferred process controlling the electrochemical evolution of groundwater within this aquifer. Traditional models which describe a progressive reduction of the electrochemical state of groundwater along the flow path cannot be directly applied to the Tucson basin which is a 'dispersive influx-dominated' system. (Author's abstract)
W88-05537

**PROFILE CHARACTERISTICS DURING EXTENDED GRAVITY DRAINAGE UNDER FALLING WATER TABLE CONDITIONS,**
New South Wales Univ., Kensington (Australia). Dept. of Civil Engineering.
K. K. Watson.
Water Resources Research WRERAO, Vol. 24, No. 1, p 178-182, January 1988. 5 fig, 3 ref.

Descriptors: *Drainage, *Water table decline, *Groundwater movement, Porous media, Water table, Water level, Soil water, Capillary water, Gravity flow, Computers, Mathematical equations.

A computer-based numerical analysis of the equation describing water movement in unsaturated porous materials is used to provide data on the shape of the water content profile and the thickness of the draining capillary fringe during extended gravity drainage when the water table is permitted to fall at a constant velocity to a considerable depth below the surface. These velocities of water table fall are considered in conjunction with zero and nonzero surface flux considerations. The numerical results are used to assess the validity of an approach based on the assumption that during extended drainage the draining profile retains its shape with continued water movement. For the zero flux case the assumption is of limited use, whereas, in the presence of an applied surface flux, the profile shape may be accurately defined depending on the magnitude of the rate of water table fall. In calculations involving the thickness of the draining capillary fringe, the equations developed using the constant shape assumption reduce to the equivalent Green and Ampt forms. (Author's abstract)
W88-05543

**GROUNDWATER TRANSPORT OF THE HERBICIDE, ATRAZINE, WELD COUNTY, COLORADO,**
Colorado State Univ., Fort Collins. Inst. of Rural Environmental Health.
For primary bibliographic entry see Field 5B.
W88-05619

**PROCEEDINGS OF THE 1986 INTERNATIONAL SYMPOSIUM ON BIOFOULED AQUIFERS: PREVENTION AND RESTORATION.**
American Water Resources Association, Bethesda, MD.
For primary bibliographic entry see Field 5C.
W88-05724

**MICROBIAL COLONIZATION OF SURFACES,**
Saskatchewan Univ., Saskatoon. Dept. of Applied Microbiology and Food Science.
D. E. Caldwell.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 7-9, 6 ref.

Descriptors: *Colonization, *Aquifer characteristics, *Microbiological studies, *Bacterial growth, *Biofouling, Growth kinetics, Salinity, Sodium hypochlorite, Computers, Bacterial physiology.

Computer image analysis was used to observe bacteria colonizing the wall of a 1 x 2 mm glass flow cell. Monod uptake kinetics, developed for the study of cell suspensions, failed to adequately describe the kinetics of substrate uptake for attached cells. It appears that attached cells may chemically modify the surface to more effectively utilize it as a mechanism for capturing transient substrate at low concentrations. Surface colonization involved four discrete types of cell movement, designated as packing, spreading, shedding and rolling maneuvers. Each maneuver was associated with unique growth kinetics. The effects of environmental stresses was also studied. Attached cells recovered from salt stress up to 3 M concentrations. Salinity also affected the timing of the recolonization phase. Attached cells were extremely sensitive to the effect of sodium hypochlorite. At a concentration of 0.5 ppm, the cells were unable to grow but recovered when hypochlorite was removed. At 5.0 ppm, cells were unable to recover, and at 50.0 ppm, cells were actively removed from the surface. (See also W88-05724) (Author's abstract)
W88-05726

**ECOLOGY OF IRON AND MANGANESE BACTERIA IN UNDERGROUND WATER,**
Institute for Technology of Nuclear and Other Mineral Raw Materials, Belgrade (Yugoslavia).
F. Barbic, A. Spasic, M. Vukovic-Pal, I. Savic, and D. Bracilovic.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 11-22, 1 fig, 6 tab, 13 ref.

Descriptors: *Aquifer characteristics, *Groundwater quality, *Ecology, *Iron bacteria, *Microbiological studies, *Well yield, *Manganese bacteria, Sedimentation, Chemical analysis, Population dynamics, Flow velocity, Dissolved oxygen, Yugoslavia, Wells.

This investigation on the occurrence and effects of iron and manganese bacteria in groundwaters of Novi Sad, Obrenovac, Mladenovac, Leskovac and Belgrade (Serbia, Yugoslavia) suggests some common features at these sites. The results of comparative analyses of iron bacteria population in different groundwaters (different locations, age of well, pumping rate, permeability coefficient, chemical composition, etc.), as well as specific biotic and abiotic environmental factors, allowed identification of some regularities in the inter-relationship between bacteria and sedimentation of ochre (i.e., thereby decreasing the production rate of wells). Qualitative and quantitative composition of iron and manganese bacteria population in the mentioned waters is different and variable. It is obvious that the ecological factors and their interaction influence the variation of bacterial population and sedimentation of ochre. The results of these investigations indicate the presence of iron and manganese bacteria in all tested samples of groundwaters. Almost without exception (in wells and observation wells), such genera' as Siderocapsa, Gallionella and Leptothrix were detected. Regularly, higher densities of these populations were found in deeper groundwaters where the velocity of water is higher (naturally or by a pumped-well system), i.e., the presence of oxygen and iron is higher so that the redox processes are more intensive. (See also W88-05724) (Author's abstract)
W88-05727

**PHYSICO-CHEMICAL FACTORS IN INFLUENCING THE BIOFOULING OF GROUNDWATER,**
Regina Water Research Inst. (Saskatchewan).
D. R. Cullimore.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 23-36, 12 fig, 4 ref.

Descriptors: *Aquifer characteristics, *Groundwater pollution, *Biofouling, *Groundwater quality, *Water pollution effects, Chemical properties, Biomass, Corrosion, Physical properties, Hydrogen ion concentration, Water temperature, Nutrients, Dissolved oxygen, Carbon dioxide, Water quality, Groundwater pollution, Biodegradation.

In projecting the potential influence of the various physical and chemical parameters on the generation of biofouling, the target biological causal agents are grouped and defined. In this differentiation, the two major categories proposed are based upon whether the primary effect is the generation of biomass (group 1) or corrosive activities (group 2). A complex interrelatedness between these two major groups is such that the physico-chemical factors influencing growth and activity remain difficult to define. To reconcile the relative factoral importance of the various physical (e.g., pH, temperature, redox, surface characteristics, porosity, flow time) and chemical (e.g., macro and micro nutrients, oxygen, carbon dioxides, salts, specific pollutants) parameters, a series of interactive plots are proposed as the first step in understanding the occurrence and predicting the development of biofouling in wells and groundwater systems. (See also W88-05724) (Author's abstract)
W88-05728

**ROLE OF BACTERIAL POLYMERS IN METAL RELEASE INTO WATER,**
Harvard Univ., Cambridge, MA. Lab. of Microbial Ecology.
J. P. Black, T. E. Ford, and R. Mitchell.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 37-42, 1 fig, 1 tab, 21 ref.

Descriptors: *Path of pollutants, *Bacteria, *Polymers, *Metals, *Biofilms, *Water pollution sources, *Aquifers, Biodegradation, Microbiological studies, Nutrients, Iron, Manganese, Groundwater quality, Interstitial water, Ecosystems.

Microorganisms adhere rapidly to surfaces in soil or water, and within days, an established biofilm develops. A typical microbial biofilm comprises a mixed community of bacteria in a matrix of bacterial exopolymers which bind nutrients and iron and manganese species out of the aquatic phase. Soluble exopolymer/metal complexes are periodically released in the soil pore water and might then be carried to an underlying aquifer. Reported upon here are studies of metal binding by bacterial exopolymers and studies of the fate of soluble exopolymer/metal complexes in soil cores. Microbial exopolymers may be important in the enrichment of iron and manganese in groundwater. Initial data showed that: (1) More of the soluble exopolymer/metal complex (P/M) was retained in live soil cores (92.5%) than in sterile cores (33.0%); (2) In unsterilized cores, more total manganese was released from P/M application (7% of applied Mn released) than from an application of manganese, alone (3% of applied Mn released). This suggests that metal bound to exopolymers stays in solution more than free metal; (3) A considerably higher percentage of metal was released in the high molecular weight fraction in live (45%), as opposed to sterile (28%), soil columns. (See also W88-05724) (Lantz-PTT)
W88-05729

**CLOGGING OF DISCHARGE WELLS IN THE NETHERLANDS II: CAUSES AND PREVENTION,**
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
C. G. E. M. Van Beek.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 43-56, 6 fig, 1 tab, 25 ref.

Descriptors: *Aquifer characteristics, *Well performance, *Well screens, *Clogging, *Discharge wells, *Netherlands, *Water pollution effects, Biodegradation, Groundwater quality, Chemical analysis, Oxygen, Iron bacteria, Manganese, Methane, Sulfur bacteria, Sulfates.

Clogging present as an accumulation of iron-hydroxides and/or manganese-oxides and/or biomass located in the screen slots of a well is caused by the mixing of incompatible groundwater chemistries. These incompatible mixtures occur when one well abstracts as well as oxygen-containing groundwater, and/or manganese, and/or methane containing groundwater. Clogging present on the borehole-aquifer interface is caused by an enhancement of

existing processes by the increased groundwater flow toward a well. There are several indications that such a process might be sulfate reduction. This activity could be prevented by suppressing the biological activity. As sulfate reducing bacteria are obligate anaerobic bacteria, this might be achieved by making the environment periodically aerobe as by underground iron removal. Mechanical clogging is very poorly understood. There are well fields where only a few wells clog, and it is presumed that these wells are clogged by an accumulation of fine sand and silt. Until now, this type has only been found in deep wells (> 100 m) which abstract an aerobic groundwater and not in wells which abstract aerobic groundwater, which are usually not so deep. The occurrence only in deep wells may point to an improper placing of the gravelpack or to an improper choice of the grain-diameter. (See also W88-05724) (Lantz-PTT)
W88-05730

**BIOFILMS IN POROUS MEDIA,**
Montana State Univ., Bozeman. Inst. for Biological and Chemical Process Analysis.
W. G. Characklis, A. B. Cunningham, A. Escher, and D. Crawford.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 57-78, 12 fig, 25 ref. Geological Survey Grant No. 14-08-0001-01284, Office of Naval Research Grant No. N00014-84-K-0309, and NSF Grant No. CTB-8420785.

Descriptors: *Clogging, *Aquifer charateristics, *Groundwater quality, *Biofilms, *Fouling, *Porous media, Chemical analysis, Microbiological studies, Hydraulic properties, Model studies, Flow patterns, Resistance.

A long-term fundamental research program is intended to provide a better understanding of microbial, chemical and hydraulic processes in porous media. Plans include an extension of results and application of techniques from previous research on fundamental biofilm processes to porous media flow systems. The intent is to develop instrumentation and methods for monitoring porous media fouling in field applications. Finally, practical models for describing biofilm accumulation in porous media, are developed. Described here are the proposed programmatic approach, including the conceptual description of biofilm accumulation and the perceived manner in which biofilms interact with the porous media to influence hydraulic resistance. Applications of several methods, unique to the study of microbial activity in porous media, are also discussed. Several issues related to modeling are also considered. (See also W88-05724) (Author's abstract)
W88-05731

**BIOLOGY OF GALLIONELLA,**
Goeteborg Univ. (Sweden). Dept. of Marine Microbiology.
For primary bibliographic entry see Field 5B.
W88-05733

**BIOLOGY OF LEPTOTHRIX, GALLIONELLA, AND CRENOTHRIX: RELATIONSHIP TO PLUGGING,**
Cornell Univ., Ithaca, NY. Dept. of Microbiology.
W. C. Ghiorse.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 97-108, 6 fig, 3 tab, 15 ref. EPA Contract No. CR811148.

Descriptors: *Iron bacteria, *Aquifer characteristics, *Biological studies, *Leptothrix, *Gallionella, *Crenothrix, *Clogging, *Water quality, Microbiological studies, Iron, Manganese, Bacterial growth, Wells, Oxygen, Toxicity, Bacteria, Membranes, Ultrastructure.

Leptothrix discophora is a sheathed, manganese-oxidizing pseudomonad that is readily cultured on a variety of heterotrophic media. The sheath, in which iron and manganese oxides accumulate, is composed of carbohydrate, protein and lipid. A sheathless strain has been shown to excrete a protein that catalyzes oxidation of Mn(2+) to Mn(IV) oxide extracellulary without energy gain to the cell. The production of extracellular manganese and iron oxide may protect the cells from toxic environmental factors. Gallionella ferruginea can be grown in microaerobic gradient cultures where sufficient amounts of Fe(2+) and O2 coexist. Recent ultrastructural evidence showing polyhedral inclusions that resemble carboxysomes supports the traditional theory that G. ferruginea is a chemoautotroph deriving from oxidation of Fe(2+) to fix CO2 via the Calvin-Benson cycle. High resolution electron microscopy shows that the stalk consists of numerous electron dense fibrils emanating from the concave side of the cell. As the stalks age, they become heavily encrusted with iron hydroxide. Crenothrix polyspora is another sheathed bacterium, but compared to members of the Sphaerotilus-Leptothrix group, little is known of its biology. C. polyspora does not deposit iron or manganese extensively, but it does produce large filamentous aggregates that can cause severe plugging problems. Ultrastructural studies of samples from infected wells show that C. polyspora cells contain extensive internal membrane systems suggestive of those found in Type I methane-oxidizing bacteria. (See also W88-05724) (Author's abstract)
W88-05734

**PREDICTION OF BIOFOULING,**
Georgia State Univ., Atlanta.
P. E. Gaffney.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 121-125, 3 tab, 2 ref.

Descriptors: *Biofouling, *Prediction, *Water quality, *Aquifers, Wells, Environmental effects, Nutrients, Bacteria, Groundwater pollution, Hydrogen ion concentration, Dissolved oxygen, Water temperature, Fouling, Biofilms, Pumping, Conductivity.

No aquifer is sterile, and since microorganisms are ubiquitous, every aquifer system, including both solid and aqueous phases, will contain an indigenous microbial population. There are microorganisms which can grow at -18 or 250 C and in between, in the absence of air, at optimal pH levels near 2.0, or that can use KCNS as a sole carbon, nitrogen and energy source. They can reproduce in a matter of minutes, adapt to adversity and genetically vary in hours and significantly change an environment in a matter of days. A list of the more important factors which affect the rate of biofouling is presented with the factors grouped into organismal, environmental and operational categories. Operational factors can have a profound effect in terms of the artificial introduction of microbial contaminants into a groundwater system during construction, utilization of or repair of a well. This operational component can also lead to the introduction of nutrients which may accelerate the growth of microbes and development of the biofilm. The environmental component would have to be considered from the standpoint of local geological factors and the opportunity for groundwater pollution through waste dumps, landfills, leaking storage tanks or ambient stream pollution. Given the proper nutrition, the rate of growth and biofouling would be affected by other environmental factors in a direct manner. Thus, lower temperature, redox potential, dissolved oxygen, pH and conductivity would result in lower growth and fouling rates. There would also be a direct relationship with the degree of natural or operational mixing and movement of the water since this would increase opportunities for convergence of biofilm and nutrients. Long stationary periods between pumping cycles would allow utilization of fresh nutrients and establishment of biofilm. Once the biofilm is established, continuous pumping may be more unfavorable because the fixed or attached organisms can act as a 'metabolic filter' for the moving nutrients. (See also W88-05724) (Lantz-PTT)
W88-05736

**OCCURRENCE OF IRON BACTERIA IN WELLS IN RIO NEGRO (ARGENTINA),**
Departamento Technico Lab., Viedma (Argentina).
R. E. Alcade, and E. C. DeKnott.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 127-136, 5 fig, 3 tab, 8 ref.

Descriptors: *Aquifer characteristics, *Iron bacteria, *Negro River, *Argentina, *Wells, *Water quality, Groundwater pollution, Microbiological studies, Gallionella, Geohydrology, Iron, Manganese.

Seven cases of contamination of water supply wells with iron bacteria, in different locations of Rio Negro (Argentina), are presented. A description of well characteristics, geological profiles, chemical analysis of water, symptoms and iron bacteria observed in each case is listed. In the so-called South-Line, an arid region in the south of the province, four wells (shortly after their drilling) became infested with iron bacteria of the Sphaerotilus-Leptothrix group; one had severe corrosion in the pumping equipment whose possible bacterial source was not yet investigated. The other three cases reported are wells of the alluvial terrains of the Negro River valley, where the groundwater contains iron and manganese; Gallionella and members of the Sphaerotilus-Leptothrix group were the iron bacteria detected. (See also W88-05724) (Author's abstract)
W88-05737

**OXIDATION PROCESSES OF IRON IN GROUND WATER - CAUSES AND MEASURES,**
Stockholm Univ. (Sweden). Dept. of Geology.
For primary bibliographic entry see Field 5C.
W88-05739

**GROUND WATER BIOGEOCHEMISTRY OF IRON AND MANGANESE IN RELATION TO WELL WATER QUALITY,**
Helsinki Univ. (Finland). Dept. of Geology.
A. Vuorinen, L. Carlson, and O. H. Tuovinen.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 157-168, 5 fig, 1 tab, 57 ref.

Descriptors: *Groundwater quality, *Geochemistry, *Iron, *Manganese, *Wells, *Chemical reactions, *Well water, *Iron bacteria, Chemical properties, Filtration, Aeration, Water treatment, Copper, Silicon, Fluorine, Sorption.

Excess iron and manganese are a common problem in many groundwater treatment plants. Treatment plants are briefly described which utilize natural aeration and macadam filters to oxidize and precipitate iron and manganese from groundwater. These treatment stages precede clarification and either slow sand filtration or infiltration for the final removal of precipitated metals. Microscopic observations indicate the establishment of iron-precipitating bacteria in filter materials, but the biological transformations of Fe and Mn in these systems have not been characterized. The sorption of Fe seems to be promoted by the association of silica with precipitating hydrous iron oxides. The sorption of silica from water seems to have inhibited the crystallization of lepidocrocite and caused the formation of ferrihydrite, whose ordering was hampered by sorbed silica. The sorption of silica results in a change in the zero point charge of the hydrous iron oxides and allows the sorption of cations. Further, the sorption and scavenging of fluoride by the precipitating hydrous iron oxides from groundwater prevented their ordering. The amounts of loosely bound Fe, Si and F of the precipitates were correlated with each other, they decreased along the flow path and increased during aging of the precipitates. Cu was strongly sorbed and scavenged by these precipitates. In general, hydrous oxides of Fe(III) and Mn(IV) scavenge minor and trace metals, including toxic elements, and thereby constitute a natural enrichment mechanism to immobilize and remove metal ions from water. Manganese was mainly sorbed in Fe(III)-oxide sediments in the treatment plants. (See also W88-05724) (Lantz-PTT)
W88-05740

**MULTI-SOLUTE SUBSURFACE TRANSPORT MODELING FOR ENERGY SOLID WASTES.**
Department of Energy, Washington, DC. Div. of Ecological Research.
For primary bibliographic entry see Field 5B.
W88-05753

**EFFECTS OF CONSERVATION TILLAGE ON GROUNDWATER QUALITY: NITRATES AND PESTICIDES,**
Ohio State Univ., Columbus. Dept. of Soil Chemistry.
For primary bibliographic entry see Field 4C.
W88-05759

**MICROCOMPUTER PROGRAMS FOR GROUNDWATER STUDIES,**
D. Clarke.
Elsevier, Amsterdam, The Netherlands. 1987. 254 p.

Descriptors: *Groundwater management, *Groundwater, *Computer programs, Physical properties, Surface-groundwater relations, Piezometry, Groundwater recharge, Flow profiles, Computers.

This book provides a selection of subroutines and programs with as wide and as basic as possible an application to groundwater science, and to explain their operation. The first programs to be described are functions usable as subroutines in practical applications. These are then used to solve typical groundwater problems. More functions and procedures are introduced, and applied in generally more involved groundwater situations as the reader progresses into the book. A program to produce a disk file from discharge test data, and to analyze those data, is given later, as well as a program to graph the data. An analytical model of changes in the piezometric surface due to a number of discharging or recharging wells is included. Most of the programs can be used with any set of consistent units. Where units are specified, they are metric. The programs are designed to be run with little prior instruction. Prompts given by the computer should be sufficient information about what is required for the user to get right through a particular program with no more than an occasional reference to the written instructions. (Lantz-PTT)
W88-05778

**ANALYSIS OF PUMPING TESTS OF THE CULEBRA DOLOMITE CONDUCTED AT THE H-11 HYDROPAD AT THE WASTE ISOLATION PILOT PLANT (WIPP) SITE,**
INTERA Technologies, Inc., Austin, TX.
G. J. Saulnier.
Available from the National Technical Information Service, Springfield, VA. 22161 as DE87-008892. Price codes: A07 in paper copy; A01 in microfiche. Sandia National Laboratories Contractor Report No. SAND87-7124, September 1987. 198 p, 42 fig, 41 ref, 3 append. Contract No. DE-AC04-76DP00789.

Descriptors: *Pumping tests, *Culebra Dolomite, *Pilot plants, *Radioactive waste disposal, *Geohydrology, *Groundwater, Hydrologic properties, Transmissivity, Storativity, Computer programs, Porosity.

The Culebra Dolomite Member of the Permian Rustler Formation was hydrologically evaluated in a series of pumping tests conducted at the H-11 hydropad at the Waste Isolation Pilot Plant (WIPP) site in 1984 and 1985. Three pumping tests performed in 1984 consisted of 12- to 21-hour pumping periods at each of the three wells, while using the other two wells at the hydropad as observation wells. The 1985 pumping test was conducted at H-11b3 with H-11b1 and H-11b2 as observation wells. The 1985 test was a 32-day multirate test with four pumping and recovery periods. The pumping tests at the H-11 hydropad were analyzed with the INTERPRET reservoir-analysis software developed by Scientific Software-Intercomp. The analysis of the test data from both test periods indicates that at H-11, the Culebra dolomite behaves as a multilayered, double-porosity reservoir with slab-type geometry. The INTERPRET analysis of the H-11 pumping tests provided estimates of the double-porosity parameters omega and lambda. Omega is defined as the ratio of the storage capacity of the secondary-porosity system of the producing formation, usually considered to be fractures, to the storage capacity of the combined primary- and secondary-porosity systems. The range of values calculated for the double-porosity parameter omega in the observation wells was 0.3 to 0.43 for the 1984 tests and 0.07 for the 1985 test. The lower value for 1985 is probably due to the fact that the Culebra in all wells for this testing period was packer-isolated. Using INTERPRET, the average transmissivity of the Culebra was calculated to be 23.2 sq ft/d for the 1984 tests, 26.2 sq ft/d for the 1985 test, and 24.0 sq ft/d using the results of all the tests. The storativity of the Culebra, as determined from the pumping tests, is between 0.0029 and 0.00045. The skin factors calculated from the pumping-well data range from -3.3 to -4.6, indicating that these wells behave as stimulated wells. (Lantz-PTT)
W88-05848

**REGIONAL DOUBLE-POROSITY SOLUTE TRANSPORT IN THE CULEBRA DOLOMITE: AN ANALYSIS OF PARAMETER SENSITIVITY AND IMPORTANCE AT THE WASTE ISOLATION PILOT PLANT (WIPP) SITE,**
INTERA Technologies, Inc., Austin, TX.
For primary bibliographic entry see Field 5B.
W88-05852

**GROUND WATER MANUAL: A GUIDE FOR THE INVESTIGATION, DEVELOPMENT, AND MANAGEMENT OF GROUND-WATER RESOURCES.**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
John Wiley and Sons, New York, New York. 1981. 480 p.

Descriptors: *Groundwater, *Groundwater management, *Manuals, *Geohydrology, Groundwater movement, Wells, Aquifers, Aquifer testing, Aquifer characteristics, Groundwater budget, Geophysics, Permeability, Well design, Pumping, Groundwater mining, Bibliographics.

This manual was prepared as a guide to field personnel in the more practical aspects and commonly encountered problems of groundwater investigations, development, and management. Information is presented concerning such aspects as groundwater occurrence and flow, well-aquifer relationships, groundwater investigations, aquifer test analysis, estimating aquifer yield, data collection, and geophysical investigations. In addition, permeability tests, well design, dewatering systems, well specifications and drilling, well sterilization, pumps, and other aspects have been discussed. An extensive bibliography has also been included. (Lantz-PTT)
W88-05853

**GROUNDWATER MODELLING: AN INTRODUCTION WITH SAMPLE PROGRAMS IN BASIC,**
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
W. Kinzelbach.
Developments in Water Science, No. 25. Elsevier, New York. 1986. 333 p.

Descriptors: *Groundwater movement, *Geohydrology, *Path of pollutants, *Computer programs, *Water quality, *Water supply, *Groundwater management, *Model studies, *Environmental effects, Aquifers, Mathematical models, Mathematical studies, Computers.

In many countries groundwater is one of the major drinking water resources. As such it must be managed and protected carefully if it is to be put to the most beneficial use. With growing development of the resource and with growing human impact on the aquifers, the management needs become more visible. Problems like overpumping of aquifers and pollution of groundwater occur with increasing frequency. To mitigate conflicts of interests and avoid severe, even irreversible environmental damage, one must be able to predict the reactions of aquifers to human impact with respect to both groundwater quantity and quality. As regional-scale phenomena usually cannot be studied in laboratory-scale physical models, mathematical tools of analysis must be applied. The chapters of this book present mathematical models which comprise models of groundwater flow and pollution transport. The process of mathematical modelling involves a number of different steps. The essential ones are: (1) Posing the problem; (2) Choice of variables; (3) Determination of the quantitative interdependence of variables; (4) Choice of solution algorithms and implementation on a computer; (5) Determination of model parameters; (6) Verification of the model; and (7) Application of the model. (Lantz-PTT)
W88-05908

**WIPP HYDROLOGY PROGRAM WASTE ISOLATION PILOT PLANT, SOUTHEASTERN NEW MEXICO: HYDROLOGIC DATA REPORT NO. 5,**
INTERA Technologies, Inc., Austin, TX.
W. A. Stensrud, M. A. Bame, K. D. Lantz, A. M. LaVenue, and J. B. Palmer.
Available from the National Technical Information Service, Springfield, VA. 22161 as DE88-003613. Price codes: A99 in paper copy; A01 in microfiche. Sandia National Laboratory Contractor Report No. SAND87-7125, October 1987. 604 p, 146 fig, 4 tab, 30 ref, 18 append. DOE Contract No. DE-AC04-76DP00789.

Descriptors: *Groundwater level, *Geohydrology, *Groundwater movement, *New Mexico, *Pumping tests, Observation wells, Waste isolation pilot plant, Water level, Geohydrology, Culebra dolomite, Monitoring, Pumping tests, Magenta dolomite.

Water level data was used as part of an effort to characterize the WIPP site hydrogeologically. There are 46 wells completed in the Culebra and eight wells completed in the Magenta. Wells H-1 and H4a have a Production-Injection Packer (PIP) installed to separate and isolate the Culebra and Magenta. However, because of borehole-equipment conditions, the Magenta is inaccessible to water level measuring instruments in well H-4a. Wells H-3b1, H-4c, H5c, and H-6c have retrievable bridge plugs installed between the Culebra and Magenta dolomites and were only open to the Magenta during this report period. Also, the Cabin Baby-1 well was converted from monitoring the Bell Canyon and Castile Formations to monitoring the Culebra dolomite by installing a retrievable bridge plug and perforating the Culebra dolomite interval through its 10-3/4-inch casing. The hydrologic testing activities that occurred during the report period include a long-term, multipad pumping test at WIPP-13 (Part A of the report), attempted slug tests at P-15, slug tests at wells P-17, ERDA-9, and Cabin Baby-1 (Part B of this report), and drill-stem testing at H-15 (Part D of this report. The attempted slug tests at P-15 and the slug tests at P-17 and Cabin Baby-1 were conducted using water bailed from these boreholes, and presumably from the formation near these boreholes, to overpressure the Culebra test interval. All fluid removed from ERDA-9 during cleaning and bailing operations contained chemical derivatives of diesel-based drilling fluid which required disposal at a licensed disposal facility. Therefore, fresh water was used to overpressure the Culebra test interval for the ERDA-9 slug tests. These slug tests may have altered the density of the fluid column in these boreholes and, therefore, may have affected the measured water levels. (Lantz-PTT)
W88-05912

## 2G. Water In Soils

**MODELING SURGE IRRIGATION INFILTRATION,**
Texas Univ. at Austin. Center for Research in

Water Resources.
For primary bibliographic entry see Field 3F.
W88-05138

**FURROW MODEL WITH SPECIFIED SPACE INTERVALS,**
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 3F.
W88-05140

**GREEN-AMPT--MODEL TO PREDICT SURGE IRRIGATION PHENOMENA,**
Arizona Univ., Tucson. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W88-05143

**UPWARD INFILTRATION EQUATIONS IN POWER-LAW FORM,**
Hawaii Univ. at Manoa, Honolulu. Dept. of Civil Engineering.
Y.-S. Fok, and S. Chiang.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 595-601, November 1987. 1 fig, 2 tab, 7 ref. DOI Grant No. 14-08-0001-G1221.

Descriptors: *Drip irrigation, *Model studies, *Infiltration rates, *Mathematical equations, *Infiltration, Equations, Prediction, Estimating.

One-dimensional upward water movement, the accumulative infiltration, and the infiltration rate can be expressed by explicit power algebraic equations. Three consecutive equations developed from three time zones for upward infiltration are enough to cover the whole range of upward infiltration and give good results. The validity of the derived equations for upward water movement, cumulative infiltration, and infiltration rate have been examined by using data measured by Green and Ampt, and Miller and Gardner. Both sets of measured data agree with their corresponding computed data. (Alexander-PTT)
W88-05145

**EFFECT OF VINASSE ON SOIL ACIDITY,**
Sao Paulo Univ., Piracicaba (Brazil). Escola Superior de Agricultura Luiz de Queiroz.
For primary bibliographic entry see Field 5E.
W88-05274

**PRODUCTIVITY AS A POPULATION PERFORMANCE INDEX IN LIFE-CYCLE TOXICITY TESTS,**
Vrije Univ., Amsterdam (Netherlands). Biological Lab.
For primary bibliographic entry see Field 5C.
W88-05293

**TIME SCALE OF THE SOIL HYDROLOGY USING A SIMPLE WATER BUDGET MODEL,**
IBM, Paris (France). Paris Scientific Center.
Y. V. Serafini, and Y. C. Sud.
Journal of Climatology JOUCD2, Vol. 7, No. 6, p 585-591, November-December, 1987. 3 fig, 5 ref.

Descriptors: *Soil water, *Model studies, *Hydrologic budget, *Drought, *Temporal distribution, *Hydrology, Distribution, Rainfall, Evaporation, Saturated soils, Soil types, Estimating equations, Mathematical equations, Mathematical models, Climatology.

A simple water budget model was used to obtain a characteristic time scale of the soil hydrology, which is defined as the time scale for the onset of agricultural droughts. Assuming that there is no rain, this estimation requires as input the knowledge of the initial soil moisture content and an evaluation of the potential evaporation. Two applications at a global scale are shown. In a first case, an initially saturated soil is considered to get an estimation of the time needed by a climate model to adjust realistically to initial errors in the soil moisture distribution. In a second case, climatological values are used as initial conditions to get a measure of the sensitivity of the hydrological cycle to the atmospheric forcing. (Author's abstract)
W88-05311

**RAPID WATER TABLE RESPONSES TO RAINFALL IN A NORTHERN PEATLAND ECOSYSTEM,**
George Mason Univ., Fairfax, VA. Dept. of Biology.
For primary bibliographic entry see Field 2A.
W88-05402

**INFILTRATION CAPACITY OF DISTURBED SOILS: TEMPORAL CHANGE AND LITHOLOGIC CONTROL,**
Colorado State Univ., Fort Collins. Dept. of Earth Resources.
D. W. Jorgensen, and T. W. Gardner.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1161-1172, December 1987. 11 fig, 6 tab, 30 ref. USDOE Grant DE FG02-84ER60263.

Descriptors: *Infiltration capacity, *Soil water, *Disturbed soils, *Infiltration, Model studies, Infiltration rates, Coal mining, Capacity, Soil properties, Soil surfaces, Runoff volume, Runoff, Horton infiltration equation, Mathematical studies, Regression analysis, Soil physical properties.

The hydrologic character and response of disturbed land is controlled, to a large degree, by soil infiltration characteristics. Reconstructed soils on surface mines (minesoils) of different age (1 to 4 years old) were used to investigate infiltration rates on disturbed landscapes. The data consist of soil/surface properties and runoff volumes fit to the Horton infiltration equation. Infiltration rates on newly reclaimed minesoils are an order of magnitude lower than adjacent, undisturbed soil. Few significant correlations exist between soil/surface properties and infiltration parameters for newly reclaimed soils. However, the correlation between infiltration and minesoil characteristics increases with soil age. Multiple regressions are used to explore relationships between infiltration parameters and soil/surface properties for each soil age. Regression models of 30-minute infiltration volume and the steady-state rate consistently include the percent silt and clay, slope, bulk density, and vegetation. Mean infiltration volumes at different mines are equal in the first year following reclamation, but become significantly different with surface age. The magnitude of the increase is controlled by the soil texture, vegetation, slope, and bulk density. Soil characteristics are determined ultimately by the overburden lithology and its effect on mineralogy and grain size during physical redistribution of soil particles and initial weathering. (Author's abstract)
W88-05420

**NUMERICAL ANALYSIS OF THE NONSTEADY TRANSPORT OF INTERACTING SOLUTES THROUGH UNSATURATED SOIL 1. HOMOGENEOUS SYSTEMS,**
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Dept. of Soil Physics
For primary bibliographic entry see Field 5B.
W88-05441

**NUMERICAL ANALYSIS OF THE NONSTEADY TRANSPORT OF INTERACTING SOLUTES THROUGH UNSATURATED SOIL 2. LAYERED SYSTEMS,**
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Dept. of Soil Physics
For primary bibliographic entry see Field 5B.
W88-05442

**SIMULATION OF THE EFFECTS OF FOREST COVER, AND ITS REMOVAL, ON SUBSURFACE WATER,**
Northern Forest Research Centre, Edmonton (Alberta).
For primary bibliographic entry see Field 4C.
W88-05444

**NEW APPROACH FOR SIZING RAPID INFILTRATION SYSTEMS,**
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 5D.
W88-05521

**SCALE DEPENDENCE AND THE TEMPORAL PERSISTENCE OF SPATIAL PATTERNS OF SOIL WATER STORAGE,**
Guelph Univ. (Ontario). Dept. of Land Resource Science.
R. G. Kachanoski, and E. de Jong.
Water Resources Research WRERAO, Vol. 24, No. 1, p 85-91, January 1988. 5 fig, 3 tab, 11 ref.

Descriptors: *Soil water storage, *Water storage, *Spatial distribution, *Soil water, Mathematical studies, Mathematical equations, Stability analysis, Correlation analysis, Recharge, Temporal distribution.

The concept of time stability as defined by Vachaud and others is expanded to include general linear transformations in time and to account for the occurrence of spatial scale dependency. Time stability is described as the temporal persistence of a spatial pattern and is evaluated using correlation analysis of successive measurement dates. Spatial coherency analysis is suggested as a method for examining the temporal persistence of a spatial pattern as a function of spatial scale. Spatial coherency analysis was used to examine the temporal persistence of soil water storage (0-1.7 m) measured every 10 m in a 750 m long transect for drying and recharge events. Soil water recharge altered the spatial pattern of water storage although at small scales which was significantly related to surface (topographic) curvature. Drying did not alter the spatial pattern of soil water storage. The concept that soil water storage at a point is the product of hydrologic processes operating at different spatial scales is supported. The analysis can be used to relate the spatial scale of processes to independent factors. (Author's abstract)
W88-05533

**DISSOLVED OXYGEN SYSTEMATICS IN THE TUCSON BASIN AQUIFER,**
Arizona Univ., Tucson. Dept. of Geosciences.
For primary bibliographic entry see Field 2F.
W88-05537

**CONSTANT RATE RAINFALL INFILTRATION: A VERSATILE NONLINEAR MODEL: 1. ANALYTIC SOLUTION,**
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
P. Broadbridge, and I. White.
Water Resources Research WRERAO, Vol. 24, No. 1, p 145-154, January 1988. 6 fig, 55 ref, append. Australian Water Research Council Grant 84/157.

Descriptors: *Rainfall infiltration, *Model studies, *Infiltration, *Rainfall, Mathematical equations, Mathematical studies, Diffusivity, Convection, Soil properties, Porous media, Unsaturated flow, Darcy-Buckingham method, Permeability coefficient, Hydraulics, Hydraulic properties, Wave velocity.

Analytic solutions are presented for a nonlinear diffusion-convection model describing constant rate rainfall infiltration in uniform soils and other porous materials. The model is based on the Darcy-Buckingham approach to unsaturated water flow and assumes simple functional forms for the soil water diffusivity D(theta) and hydraulic conductivity K(theta) which depend on a single free parameter C and readily measured soil hydraulic properties. These D(theta) and K(theta) yield physically reasonable analytic moisture characteristics. The relation between this model and other models which give analytic solutions is explored. As C approaches infinity, the model reduces to the weakly nonlinear Burgers' equation, which has been applied in certain field situations. At the other

end of the range as C approaches 1, the model approaches a Green-Ampt-like model. A wide range of realistic soil hydraulic properties is encompassed by varying the C parameter. The general features of the analytic solutions are illustrated for selected C values. Gradual and steep wetting surface profiles develop during rainfall, aspects seen in the laboratory and the field. In addition, the time-dependent surface water content and surface water pressure potential are presented explicitly. A simple traveling wave approximation is given which agrees closely with the exact solution at comparatively early infiltration times. (See also W88-05540) (Author's abstract)
W88-05539

**CONSTANT RATE RAINFALL INFILTRATION: A VERSATILE NONLINEAR MODEL: 2. APPLICATION OF SOLUTIONS,**
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
I. White, and P. Broadbridge.
Water Resources Research WRERAO, Vol. 24, No. 1, p 155-162, January 1988. 8 fig, 5 tab, 20 ref. Australian Water Research Council Grant 84/157.

Descriptors: *Rainfall infiltration, *Infiltration, *Rainfall, Mathematical equations, Model studies, Mathematical studies, Diffusivity, Soil properties, Porous media, Unsaturated flow, Permeability coefficient, Hydraulics, Hydraulic properties, Wetting, Sorption, Surface water, Flow rates, Field tests, Wave velocity.

In a previous paper an analytical nonlinear model for constant rainfall infiltration was proposed which promised considerable versatility. In it a wide range of soil hydraulic properties are generated through the variation of a single free parameter C. Three techniques are advanced for determining this parameter. The first, a one-dimensional technique, involves simultaneous determination of sorptivity and wetting front position. The second uses measured values of surface water content at long infiltration times for rainfall rates less than the saturated conductivity. In the third, three- and one-dimensional flow rates are measured on the same soil sample. All are suitable for field applications. The practical range of the C parameter, for a variety of repacked and in situ soils, is restricted to between 1 and 2. The hydraulic conductivities and diffusivities of the model are in general agreement with independent measurements. Its moisture characteristics psi(theta), which are not matched in any way to measured characteristics, follow closely those observed. Also, the model permits predictions of the dependence of sorptivity on antecedent water content given a single measurement of sorptivity. The analytic solutions for constant flux infiltration given in the previous paper describe satisfactorily the evolution of water content profiles and surface water pressure potential in the laboratory and field without a posteriori adjustments. The mathematically simple, travelling wave approximation agrees well with observations at comparatively short infiltration times. Finally, field and laboratory measured times to ponding are predicted satisfactorily by the model's analytic expression. (See also W88-05539) (Author's abstract)
W88-05540

**TOMOGRAPHIC INVESTIGATIONS AT LANDFILL 4, HILL AIR FORCE BASE, LAYTON, UTAH,**
Weston Geophysical Corp., Westborough, MA.
For primary bibliographic entry see Field 7B.
W88-05715

**HYDROLOGIC SOIL PARAMETERS AFFECTED BY TILLAGE,**
Agricultural Research Service, Morris, MN. North Central Soil Conservation Research Center.
For primary bibliographic entry see Field 4C.
W88-05764

**HYDROLOGIC EFFECTS OF CONSERVATION TILLAGE AND THEIR IMPORTANCE RELATIVE TO WATER QUALITY,**
Iowa State Univ., Ames.
For primary bibliographic entry see Field 4C.
W88-05765

**SOLVING PROBLEMS IN SOIL MECHANICS,**
For primary bibliographic entry see Field 8D.
W88-05779

## 2H. Lakes

**HYPOLIMNETIC WITHDRAWAL AS LAKE RESTORATION TECHNIQUE,**
York Univ., Downsview (Ontario). Dept. of Biology.
For primary bibliographic entry see Field 5G.
W88-05162

**HYDRODYNAMIC DESIGN OF A METALIMNETIC LAKE AERATOR,**
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 5G.
W88-05179

**FORMATION AND FATE OF FERMENTATION PRODUCTS IN HOT SPRING CYANOBACTERIAL MATS,**
Montana State Univ., Bozeman. Dept. of Microbiology.
For primary bibliographic entry see Field 2K.
W88-05188

**SEASONAL AND SPATIAL VARIATIONS IN MERCURY METHYLATION AND DEMETHYLATION IN AN OLIGOTROPHIC LAKE,**
Wisconsin Univ.-La Crosse. River Studies Center.
For primary bibliographic entry see Field 5B.
W88-05189

**DYNAMICS OF METHANE PRODUCTION, SULFATE REDUCTION, AND DENITRIFICATION IN A PERMANENTLY WATERLOGGED ALDER SWAMP,**
Copenhagen Univ. (Denmark). Dept. of General Microbiology.
P. Westermann, and B. K. Ahring.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 10, p 2554-2559, October 1987. 1 fig, 3 tab, 40 ref. Danish Natural Science Research Council Grants 11-3982/4564 and 11-5080.

Descriptors: *Swamps, *Methane, *Sulfates, *Denitrification, *Waterlogging, Alder trees, Chemical reduction, Molybdates, Trimethylamine, Bacteria, Methane bacteria, Sulfur bacteria, Nitrates, Acetates, Methyl alcohol, Hydrogen, Temperature, Seasonal variation.

The dynamics of sulfate reduction, methane production, and denitrification were investigated in a permanently waterlogged alder swamp. Molybdate, an inhibitor of sulfate reduction,stimulated methane production in soil slurries, thus suggesting competition for common substrates between sulfate-reducing and methane-producing bacteria. Acetate, hydrogen, and methanol were found to stimulate both sulfate reduction and methane production, while trimethylamine mainly stimulated methane production. Nitrate addition reduced both methane production and sulfate reduction, either as a consequence of competition or poisoning of the bacteria. Sulfate-reducing bacteria were only slightly limited by the availability of electron acceptors, while denitrifying bacteria were seriously limited by low nitrate concentrations. Arrhenius plots of the three processes revealed different responses to temperature changes in the slurries. Methane production was most sensitive to temperature changes, followed by denitrification and sulfate reduction. No significant differences between slope patterns were observed when comparing summer and winter measurements, indicating similar populations regarding temperature responses. (Author's abstract)
W88-05192

**GROUNDWATER/LAKE DYNAMICS AND CHEMICAL EVOLUTION IN A SANDY SILICATE AQUIFER IN NORTHERN WISCONSIN,**
Wisconsin Univ., Madison. Dept. of Geology.
G. J. Kenoyer.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8618275. Ph.D Dissertation, 1986. 174 p, 22 fig, 3 tab, 78 ref, 7 append.

Descriptors: *Surface-groundwater relations, *Limnology, *Sand aquifers, *Lakes, *Groundwater movement, Flow measurement, Groundwater basins, Groundwater runoff, Chemical analysis, Hydrological regime, Silicates, Model studies, Geohydrology, Precipitation, Evaporation, Aquifers.

Groundwater flow and chemistry in a sandy silicate aquifer in northern Wisconsin were studied to determine processes which promote stability. Studies were concentrated on the groundwater system around Crystal lake in which significant groundwater chemical evolution occurred over short flowpaths. The seasonal flux of water and dissolved solids to Crystal Lake from the groundwater systems, and the importance of groundwater in regulating the lake's chemical and hydrologic budgets were examined. A method is introduced for determining the anisotropy of hydraulic conductivity by comparing the velocity of a dye tracer in the groundwater to measured head gradients. Groundwater chemical evolution along flow paths in the aquifer are analyzed and concentrations of pH, alkalinity, and PC02 are compared to groundwater age. Spatial patterns of major chemical constituents are interpreted in terms of silicate mineral weathering. Computer models are used to identify possible reactions and simulate chemical evolution along groundwater flow paths. A network of piezometers in and around Crystal Lake helped to establish spatial patterns of groundwater flow and chemistry in the sandy silicate aquifer, and monitoring of piezometers showed monthly variations in the flux of groundwater and dissolved chemical constituents to the lake. Evaporation, precipitation, and dryfall were also monitored. No streamflow or overland runoff to the lake occurs in the sandy terrain. (Cremmins-AEPCO)
W88-05203

**FIELD AND BASIN SCALE WATER QUALITY MODELS FOR EVALUATING AGRICULTURAL NONPOINT POLLUTION ABATEMENT PROGRAMS IN A SOUTH FLORIDA FLATWOODS,**
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W88-05211

**EFFECTS OF WATER LEVEL FLUCTUATIONS ON ALGAL COMMUNITIES OF FRESHWATER MARSHES,**
Iowa State Univ., Ames. Dept. of Botany.
S. M. Hosseini.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8627119. Ph.D Dissertation, 1986. 1 fig, 12 tab, 161 ref, 4 append.

Descriptors: *Flooding, *Epiphytes, *Limnology, *Marshes, *Phytoplankton, *Wetlands, *Aquatic productivity, *Algal growth, Biomass, Algae, Macrophytes, Chlorophyll, Carbon, Nitrogen.

The effect of prolonged flooding on the productivity of epiphyton and phytoplankton in freshwater marshes, the biomass of phytoplankton and epiphyton due to flooding in a freshwater marsh, and the spatial and temporal heterogeneity of epiphyton and phytoplankton in wetlands were investigated. Physico-chemical parameters were correlated with estimates of phytoplankton and epiphyton productivity and biomass and the total annual productivity of epiphyton and phytoplankton algae in a wetland under different environmental conditions was estimated. In both 1982 and 1983, prolonged flooding did not significantly increase epiphyton net productivity and biomass per unit area of artificial

substrata. However, available surface area for epiphyton increased three to four times in flooded marshes compared to unflooded ones; therefore, annual productivity and biomass per unit marsh area was significantly higher in flooded marshes than in unflooded ones. In 1982, epiphyton primary productivity per unit area of artificial substrata in marshes flooded one year was significantly higher, possibly because of increased irradiance in flooded marshes, which were largely free of emergent macrophytes. For 1983, the mean annual net primary productivity of phytoplankton was estimated as 190 mg C/wm3/day for flooded marshes versus 2290 mg C/wm/day for unflooded ones. Increased irradiance, due to macrophyte death, apparently created favorable conditions for extremely high algal biomass in marshes flooded two years compared to unflooded ones. However, differences in temperature, substrata abundance, and water depth may also play a role. (Cremmins-AEPCO)
W88-05221

**EUTROPHICATION IN WATER SUPPLY RESERVOIRS: GENERAL IMPACTS ON POTABLE WATER PREPARATION,**
Cagliari Univ. (Italy). Ist. di Igiene e Medicina Preventiva.
For primary bibliographic entry see Field 5C.
W88-05250

**EUTROPHICATION OF LAKE SAVA,**
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
For primary bibliographic entry see Field 5C.
W88-05269

**RESEARCH ON THE PHYSIOLOGICAL BASIS OF POPULATION DYNAMICS IN RELATION TO ECOTOXICOLOGY,**
Hoofdgroep Maatschappelijke Technologie TNO, Delft (Netherlands).
For primary bibliographic entry see Field 5C.
W88-05294

**RESERVOIR MANAGEMENT,**
Waco City Environmental Quality and Water Purficiation Dept. (Texas).
For primary bibliographic entry see Field 5G.
W88-05334

**BRINGING GREAT SALT LAKE FLOODS UNDER CONTROL,**
Ingersoll-Rand Co., Phillipsburg, NJ.
For primary bibliographic entry see Field 4A.
W88-05354

**COMPARISON OF FISH COMMUNITIES IN A CLEAN-WATER STREAM AND AN ADJACENT POLLUTED STREAM,**
Ohio State Univ., Columbus. Environmental Biology Program.
For primary bibliographic entry see Field 5C.
W88-05362

**OCCURRENCE OF VEGETATION ON GEOMORPHIC SURFACES IN THE ACTIVE FLOODPLAIN OF A CALIFORNIA ALLUVIAL STREAM,**
Oregon State Univ., Corvallis. Dept. of Forest Science.
R. R. Harris.
American Midland Naturalist AMNAAF, Vol. 118, No. 2, p 393-405, October 1987. 3 tab, 52 ref. National Science Foundation grant BSR-8112455.

Descriptors: *Plant populations, *Erosion, *Vegetation, *Flood plains, *Alluvial streams, Cottonwood Creek, California, Riparian vegetation, Erosion, Sedimentation, Geomorphology, Grasses, Salix hindsiana, Jugulans hindsii, Quercus lobata, Trees, Shrubs.

In the active floodplains of Cottonwood Creek, an alluvial stream in California, conditions for the establishment and growth of plants are largely controlled by periodic flooding. Flooding creates and modifies erosional and depositional surfaces which are occupied by different species. To evaluate patterns of species occurrence and dominance, geomorphic surfaces on Cottonwood Creek's floodplain were defined on the basis of vertical and horizontal position relative to the stream (i.e., flood frequency), microtopography and particle size. Vegetation sampling on these surfaces provided data for classifying communities by relative cover of common riparian species. The results indicated zonation of communities dominated by different species in relation to flood-induced disturbance. Plant communities dominated by Salix hindsiana and annual grasses were found on surfaces frequently flooded and subject to severe scouring or deposition. Populus fremontii attained dominance or shared dominance with S. hindsiana on less frequently flood surfaces and where particle size indicated less disturbance by erosion or deposition. Jugulans hindsii, Quercus lobata or mixed stands of P. fremontii/J/hindsii/Q. lobata/S. hindsiana were dominant on infrequently disturbed surfaces. (Author's abstract)
W88-05363

**GRAZING OF FRESHWATER RHODOPHYTA,**
Rhode Island Univ., Kingston. Dept. of Botany.
J. A. Hambrook, and R. G. Sheath.
Journal of Phycology JPYLAJ, Vol. 23, No. 4, p 656-662, December 1987. 1 fig, 3 tab, 37 ref.

Descriptors: *Streams, *Aquatic habitats, *Rhodophyta, *Algae, *Grazing, Invertebrates, Food habits, Nutrition, Amphipods, Caddisflies, Mayflies, Midges, Aquatic insects, Insects, Protein, Lipid.

Rhodophyta pieces were found in the guts of 13 invertebrate taxa in a stream ecosystem. These included two amphipods, two mayfly larvae, three caddisfly larvae, one beetle larva, four chironomids, and one snail. The frequencies with which the Rhodophyta were found in the guts were as follows: Audouinella, 31%; Tuomeya, 38%; Batrachospermum, 46%, and chantransia stages (not easily identified to genus or species), 54%. In the individual and choice experiments, Audouinella was ingested at the greatest rate, followed by Batrachospermum and then Tuomeya, regardless of the grazer. Caloric values (Kcal/g dry weight) were Audouinella, 5.0; Batrachospermum, 5.7; and Tuomeya, 6.8. Ingestion rates were positively correlated with protein content (highest, Audouinella, 32.3%) and negatively correlated with lipid content. The preferred food, Audouinella, is a small, simple filament with relatively high protein and low lipid contents. The least favored food, Tuomeya, is a tough, branched pseudoparenchyma with relatively low protein and high lipid contents. (Cassar-PTT)
W88-05370

**INTAKE OPERATION FOR DEEP COOLING RESERVOIRS,**
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W88-05373

**LIMNOLOGICAL INVESTIGATION IN TIERRA DEL FUEGO - ARGENTINA,**
Universidad Nacional de La Plata (Argentina). Inst. de Limnologia.
A. A. Mariazzi, V. H. Conzonno, J. Ulibarrena, J. C. Paggi, and J. L. Donadelli.
Biologia Acuatica, No. 10, p 1-74, 1987. 5 fig, 3 tab, 26 ref, append.

Descriptors: *Lakes, *Ponds, *Plankton, *Tierra del Fuego, Argentina, Limnology, Lake morphology, Glacial lakes, Oligotrophic lakes, Geomorphology, Salinity, Physical properties, Phosphorus, Manganese, Humic acids, Hydrogen ion concentration, Water temperature, Chemical properties, Phytoplankton, Zooplankton.

During November 1983 surveys were made of eight glacial lakes and eleven ponds in the Territory of Tierra del Fuego, Argentina. Geoenvironmental characteristics, physical and chemical factors, primary production and photosynthetic pigments were noted and phytoplankton and zooplankton in each body of water were studied qualitatively. Along the different morphostructural regions particular pond properties were seen. Those in the north Extra Andean Souther Patagonia had high salinity gradients and very high concentrations of phosphorus and manganese, 3.8 milligrams/liter and 2 milligrams/liter, respectively. They tended to be very shallow, with low transparency and a high concentration of suspended materials. Ponds surrounding lakes had brown, shallow water and high chlorophyll values; in some cases, iron concentrations were also significant. In the southern region, Fueguian Cordillera, little bog ponds with high concentrations of humic substances and a pH of about 5.8 which were surrounded by peat were encountered. The lakes exhibited the ultraoligotrophic conditions of high transparency, homeothermy, low chlorophyll and primary production values, and soft water dominated by calcium bicarbonate. (Wood-PTT)
W88-05380

**ASPECTS OF THE UNDERWATER LIGHT FIELD OF EIGHT CENTRAL NEW YORK LAKES,**
Upstate Freshwater Inst., Inc., Syracuse, NY.
S. W. Effler, C. M. Brooks, M. G. Perkins, M. Meyer, and S. D. Field.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1193-1201, December 1987. 3 fig, 4 tab, 23 ref.

Descriptors: *Light penetration, *Lake transparency, *Light attenuation, *Lakes, New York, Secchi disks, Opacity, Transparency, Optical properties, Absorption, Chlorophyll a, Temporal distribution.

The underwater light field of eight central New York lakes (Cross, Hatch, Moraine, Onondaga, Otisco, Seneca, Skaneateles, and Tuscarora), which represent a wide range of trophic state, was characterized through paired measurements of Secchi disc transparency (SD, m) and diffuse light attenuation (K sub d, 1/m). A total of 90 paired measurements are included in the data base. Substantial variability in the K sub s x SD product with time within individual systems, and among systems, was observed, which indicates differences in the relative contributions of absorption and scattering due to attenuation. More than 50% of the temporal variability in K sub d was attributable to attendant variations in chlorophyll a (C, mg x 1/cu m) in only two of the lakes. Estimates of the adsorption (a, 1/m) and scattering (b, 1/m) coefficients based on paired K sub d and SD measurements compared well with more precise determinations available for one of the lakes. Determinations of a and b for the eight lakes, from SD and K sub d measurements, indicated great system-specificity and temporal variability in these characteristics. The temporal variability in relative contributions of a and b to K sub d is consistent with covariation of different attenuating components and the lack of correlation between C and K sub d in most of the study lakes. (Author's abstract)
W88-05424

**PRODUCTION RATE OF PLANKTONIC BACTERIA IN THE NORTH BASIN OF LAKE BIWA, JAPAN,**
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
T. Nagata.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 12, p 2872-2882, December 1987. 8 fig, 8 tab, 43 ref. Ministry of Education, Science and Culture of Japan grant 61790227.

Descriptors: *Lakes, *Bacteria, *Plankton, *Productivity, Aquatic productivity, Lake Biwa, Japan, Seasonal variation, Vertical distribution, Thymidine uptake rate, Growth rate, Radioactive tracers, Primary productivity.

Vertical and seasonal variations in the cell number and production rate of planktonic bacteria were investigated at a pelagic site (water depth, ca. 72 m) of the north basin of Lake Biwa during April to October 1986. The (methyl-H3)thymidine uptake

rate into a cold trichloroacetic acid-insoluble fraction and the frequency of dividing cells (FDCs) were measured for each sample as indices of the bacterial production rate. The seasonal data of bacterial number, thymidine uptake rate, and bacterial growth rate based on the FDCs were correlated with one another. These bacterial variables were not correlated positively with the chlorophyll a concentration. Vertically, the maxima of both bacterial number and the thymidine uptake rate were found in the euphotic zone. The direct counting of bacteria and the measurements of thymidine uptake rate combined with the size-fractionation method revealed that more than 90% of the bacterial biomass and production rate were attributed to unattached bacteria throughout the investigation period. The carbon flux estimates of bacterial production were less certain due to the variability of the conversion factor for the thymidine uptake method and that of the calibration for the FDC method, but even when the conservative range of bacterial net production rate was used (5 to 60 micrograms of carbon per liter per day), it can be suggested that bacterial net production in the investigated area was a significant fraction (ca. 30%) of the level of the primary production rate in the same water basin. (Author's abstract)
W88-05450

**EFFECTS OF A CARBAMATE INSECTICIDE, CARBARYL, ON THE SUMMER PHYTO- AND ZOOPLANKTON COMMUNITIES IN PONDS,**
National Inst. for Environmental Studies, Tsukuba (Japan). Environmental Biology Div.
For primary bibliographic entry see Field 5C.
W88-05458

**FIELD EVALUATION OF CONTROLLED RELEASE COPPER GLASS AS A MOLLUSCICIDE IN SNAIL CONTROL,**
Blair Research Lab., Harare (Zimbabwe).
For primary bibliographic entry see Field 5F.
W88-05494

**TOPOGRAPHIC WAVES IN RECTANGULAR BASINS,**
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
T. Stocker, and K. Hutter.
Journal of Fluid Mechanics JFLSA7, Vol. 185, p 107-120, December 1987. 8 fig, 5 tab, 15 ref.

Descriptors: *Topographic, *Waves, *Mathematical models, *Lake basins, *Rectangular basins, Bays, Channels, Basins, Bathymetry, Topography, Wave reflection.

The channel model of Stocker and Hutter is used to construct topographic wave solutions in a rectangular basin on the f-plane with variable but symmetric bathymetry. It is shown that, in a narrow period band, three types of eigenmodes can be discerned which exhibit local, midscale and global structure, respectively. Wave motion can be trapped either at the long sides of the elongated basin (channel mode) or at the ends of it (bay mode) or alternatively, a basinwide phase rotation is observed (Ball mode). The new bay modes are explained as resonances of topographic wave reflection in a semi-infinite channel. The influence of the variation of the aspect ratio of the rectangle and the topography parameter on the wave periods is also investigated. (Author's abstract)
W88-05501

**DYNAMIC MODEL OF IN-LAKE ALKALINITY GENERATION,**
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
For primary bibliographic entry see Field 5B.
W88-05531

**INTERANNUAL VARIABILITY OF THE HYDROLYTIC CHARACTERISTICS AND PRODUCTIVITY OF THE PHYTOPLANKTON IN LARGE WATER BODIES OF THE NORTHWEST USSR,**
Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.
O. B. Belyakova.
Doklady Biological Sciences DKBSAS, vol. 293, No. 1-6, p 325-329, November 1987. 1 fig, 3 tab, 15 ref. Translated from Doklady Akademii Nauk SSSR, Vol. 294, No. 4, p 1017-1021, June 1987.

Descriptors: *Phytoplankton, *USSR, *Water temperature, *Photosynthesis, *Limnology, *Organic matter, *Lakes, Data interpretation, Primary productivity, Correlation coefficient, Seasonal variation.

The development of methods for determining the rate of photosynthesis of phytoplankton has enabled direct measurement of the rate of photosynthesis as a value proportional to the quantity of newly formed organic material in the water body per unit of time. Correct determinations of the level of primary production of the plankton in large water bodies in the northwest USSR were commenced two decades ago. Analysis of published data, relating to the level of planktonic photosynthesis during the period 1967-1982, showed a relationship between the quantity of organic material produced by plankton and the temperature conditions in the water body during the vegatative period. The correlation coefficient for the photosynthesis and water temperature values (normalized relative to the mean value for the water body) was 0.562 for a confidence level of 0.99. In large water bodies with mean values for the rate of water replacement over many years was found to be 0.4 per year, there was found to be a negative connection between phytoplankton productivity and the interannual variability of water replacement in the lakes. For the sample, the correlation coefficient between photosynthesis and rate of nominal water replacement values was -0.468 (confidence level = 0.98). For photosynthesis values the coefficient was +0.523( confidence level = 0.99). The correlation coefficient for the three values analyzed was +0.619 plus or minus 0.082 (confidence level = 0.999. Thus, in large water bodies of north-west USSR, the maximum photosynthesis values fall in years of relatively high temperature and minimum nominal water rate replacement values. There was also found to be a high level of correlation between relative temperature variations and the level of water replacement for the last 30 years. (Roseman-PTT)
W88-05577

**NITROGEN GAS SUPERSATURATION IN THE RECENT SEDIMENTS OF LAKE ERIE AND TWO POLLUTED HARBORS,**
Wright State Univ., Dayton, OH. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W88-05594

**VERTICAL EDDY DIFFUSIVITY DETERMINED WITH RN222 IN THE BENTHIC BOUNDARY LAYER OF ICE-COVERED LAKES,**
Wisconsin Univ.-Madison. Water Chemistry Lab.
J. A. Colman, and D. E. Armstrong.
Limnology and Oceanography LIOCAH, Vol. 32, No. 3, p 577-590, May 1987. 5 fig, 5 tab, 37 ref. State of Wisconsin, Project R/MW-11.

Descriptors: *Radon radioisotopes, *Diffusion, *Radium radioisotopes, *Eddy diffusion, *Benthic environment, *Iced lakes, *Limnology, *Mixing, Radioisotopes, Environment, Lakes, Solute transport, Model studies, Isotopic tracers.

Concentration gradients of Rn222 and Ra226 were analyzed in the benthic boundary of seven ice-covered lakes to investigate vertical eddy diffusivity, K sub z. Sediment-free samples, retrieved with a tubing sampler from as close to the bottom as 14 cm, showed that sharp Rn222 gradients persist over the sediments. A three-dimensional analytical mixing model indicated horizontal mixing would not supply significant amounts of Rn222 to midlake profiles in some flat-bottomed lakes under ice cover. One-dimensional analysis of the profiles permitted observation of change in K sub z with height above the sediments. Computed K sub z values usually decreased in a given lake toward the sediments. The range in K sub z from all lakes studies was 0.30 sq cm/s at 3.61 m above the bottom to 0.00032 sq cm/s at 0.23 m, both in Lake Mendota. The correlation between K sub z and the buoyancy density was computed. This relationship indicates turbulence arising from shear flow influences the vertical mixing in the winter boundary layer. Retarded mixing in the profundal boundary layer restricts vertical solute transport in some ice-covered lakes. (Author's abstract)
W88-05605

**BIOMASS AND PRODUCTION OF SMALL AND LARGE FREE-LIVING AND ATTACHED BACTERIA IN LAKE CONSTANCE,**
Konstanz Univ. (Germany, F.R.). Limnological Inst.
M. Simon.
Limnology and Oceanography LIOCAH, Vol. 32, No. 3, p 591-607, May 1987. 9 fig, 4 tab, 65 ref. Deutsche Forschungsgemeinschaft Grants No. Ti 115/3 and Ti 115/10-2.

Descriptors: *Biomass, *Limnology, *Secondary productivity, *Lake Constance, *Aquatic environment, *Aquatic bacteria, Bacteria, Heterotrophic bacteria, Environment, Populations, Aquatic populations, Distribution, Vertical distribution, Seasonal distribution, Organic matter, Particulate matter, Plankton, Phytoplankton, Zooplankton, Productivity, Aquatic productivity, Aquatic life, Crustaceans.

Cell numbers, biomass, and secondary production of small (0.2-1 micrometers) and large (1.0-3.0 micrometers) free-living and attached bacteria were studied in Lake Constance. Biomass as well as production rates exhibited large fluctuations vertically and seasonally. When averaged over a year, small free-living bacteria were most important for recycling of organic matter since they comprised 77% of total cell numbers and 66% of bacterial secondary production. Large free-living bacteria contained roughly half of the total bacterial biomass because of their relatively larger cell size. Although attached bacteria usually were of minor importance, they occasionally comprised about half of total bacterial production. During the phytoplankton spring bloom when bacterial production reached its maximum, 60-80% of all free-living bacteria were active as shown by autoradiography. During that period a high portion of detrital particles was colonized by metabolically active cells. The data suggest that biomass, cell size, and production of free-living bacteria are controlled by substrate input and grazing of either heterotrophic microflagellates or crustacean zooplankton. In contrast, biomass and production of attached bacteria appear to be predominantly controlled by substrate input of readily decomposable particulate organic matter. (Author's abstract)
W88-05606

**SPATIAL AND TEMPORAL VARIATION IN HYPOLIMNETIC OXYGEN DEFICITS OF A MULTIDEPRESSION LAKE,**
Baylor Univ., Waco, TX. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W88-05609

**CHLORIDE BUDGETS IN TRANSIENT LAKES: LAKES BARINGO, NAIVASHA, AND TURKANA,**
Edinburgh Univ. (Scotland). Dept. of Geophysics.
C. E. Barton, D. K. Solomon, J. R. Bowman, T. E. Cerling, and M. D. Sayer.
Limnology and Oceanography LIOCAH, Vol. 32, No. 3, p 745-751, May 1987. 5 fig, 1 tab, 17 ref. Grants No. NERC GR3/2238 and NSF EAR 81-19464, BNS 82-10735, and BNS 84-06737.

Descriptors: *Limnology, *Chlorides, *Mathematical models, *Closed basins, *Closed lakes, *Sedimentation rates, *Lake Baringo, *Lake Naivasha, *Lake Turkana, Model studies, Lakes, Africa, Diffusion coefficient, Sediments, Sedimentation, Saline lakes, Isotope studies, Springs, Hot springs.

A numerical scheme is discussed for examining the chemical evolution of closed-basin lakes with high sedimentation rates. This model allows the depth of the lake to change with time and allows for a difference between the diffusion coefficients for compacted sediment and the newly-deposited uncompacted sediment. The model is used to examine the history of two closed-basin lakes in the East African Rift, Baringo, which is fresh, and Turkana, which is brackish. Results suggest chloride accumulation times on the order of 100-200 and 3,000-5,000 yr, respectively. Stable isotopic studies of waters from the East African Rift show that these two lakes, along with Lake Naivasha, are highly evaporated, and that Lake Naivasha is the source of water of the Ol Oserian geothermal field. The hot springs to the north of the lake have a meteoric origin and cannot be derived from Lake Naivasha water. (Author's abstract)
W88-05610

**NEAR REAL-TIME FORECASTING OF LARGE LAKE SUPPLIES,**
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 2A.
W88-05616

**AS, CD, CU, PB, HG, AND ZN IN FISH FROM THE ALEXANDRIA REGION, EGYPT,**
Institute of Oceanography and Fisheries, Alexandria (Egypt).
For primary bibliographic entry see Field 5C.
W88-05625

**LIMNOLOGICAL EFFECTS OF ARTIFICIAL AERATION AT LAKE CACHUMA, CALIFORNIA, 1980-1984,**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
For primary bibliographic entry see Field 5G.
W88-05696

**OUR NATIONAL WETLAND HERITAGE: A PROTECTION GUIDEBOOK,**
For primary bibliographic entry see Field 6E.
W88-05703

**NORTH ALABAMA WATER QUALITY ASSESSMENT. VOLUME VII: CONTAMINANTS IN BIOTA,**
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
For primary bibliographic entry see Field 5B.
W88-05716

**VERTICAL, HORIZONTAL, AND DIEL DISTRIBUTION OF INVERTEBRATE DRIFT IN THE LOWER MISSISSIPPI RIVER,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
D. C. Beckett, and R. L. Kasul.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A181 439. Price codes: A03 in paper copy, A01 in microfiche. Technical Report No. E-87-5, March 1987. Final Report. 36 p, 3 fig, 4 tab, 22 ref.

Descriptors: *Mississippi River, *Invertebrates, *Drift, *Distribution patterns, Vertical distribution, Seasonal variation, Periodicity, Ecosystems, Streamflow.

Lower Mississippi River macroinvertebrate drift densities and composition were determined at 3-hr intervals over 24-hr periods in mid-May and early June 1982. Samples were taken at the surface, middepth, and near the bottom at a nearshore sampling station and at the surface and middepth at a sampling station near the navigation channel. The overall mean drift density equaled 35.0 invertebrates/100 cu m of water. Overall, Chaoborus larvae were the most common invertebrates collected, followed, respectively, by chironomid pupae, Hydra sp., Hydropsyche orris, and Hexagenia sp. The abundances of various taxa in the Lower Mississippi River's drift seem to change markedly on a site-to-site basis, as a function of the physical characteristics of the river and its substrates in a certain area. This site-to-site heterogeneity, coupled with the lack of lateral homogeneity and the definite diel periodicity exhibited by some taxa, provides evidence that, even in an immense river such as the Mississippi, many of the organisms drift as they do in small streams, traveling relatively short distances with total movement rather saltatory. (Lantz-PTT)
W88-05719

**MUSSELWATCHING IN THE BUFFALO RIVER, TIMES BEACH AND LAKE ERIE,**
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5A.
W88-05720

**HYDROLOGY AND WATER RESOURCES IN TROPICAL REGIONS,**
For primary bibliographic entry see Field 2A.
W88-05776

**ASSOCIATION OF CHLOROPHYLL A WITH PHYSICAL AND CHEMICAL FACTORS IN LAKE ONTARIO, 1967-1981,**
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 7A.
W88-05882

**STATISTICAL ASSESSMENT OF A LIMNOLOGICAL DATA SET,**
Rensselaer Polytechnic Inst., Troy, NY.
For primary bibliographic entry see Field 7C.
W88-05889

## 2I. Water In Plants

**EVALUATION OF THE IMPACT OF TWO COMMON AQUATIC PLANTS, TYPHA LATIFOLIA AND EICHORNIA CRASSIPES, ON WATER LOSS FROM FRESHWATER PONDS,**
Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.
For primary bibliographic entry see Field 2D.
W88-05202

**PREDICTIONS OF FIELD PRODUCTIVITY FOR AGAVE LECHUGUILLA,**
Centro de Investigacion en Quimica Aplicada, Saltillo (Mexico).
E. Quero, and P. S. Nobel.
Journal of Applied Ecology JAPEAI, Vol. 24, No. 3, p 1053-1062, December 1987. 6 fig, 24 ref. Centro do Investigacion en Quimica Apicada project UW-0203, U.S. Department of Energy Ecological Research Division contract DE-AC03-76-SF00012.

Descriptors: *Soil-water-plant relationships, *Irrigation effects, *Desert plants, *Agave, *Productivity, Plant fibers, Fiber crops, Plant growth, Plant populations, Mexico, Rainfall, Water index, Carbon dioxide, Environmental productivity index, Soil moisture deficiency, Moisture deficiency, Temperature, Photosynthesis.

The productivity of the water-conserving plant, Agave lechuguilla, was studied under natural conditions in southern Coahuila, Mexico, near the center of its natural distribution. Its range spans 1300 km from Texas and New Mexico southward over 100,000 sq km of rocky soils which receive annual rainfall of 200-800 mm. Net CO2 uptake over 24-hour periods was used to assess plant productivity. CO2 uptake during the dry season could be increased fourfold by irrigation and nearly threefold by increasing the total daily photosynthetically active radiation (PAR) in the planes of the leaves from 6 to 17 mol/sq m. Productivity, measured as the number of leaves that unfolded each month, was highly correlated with an environmental productivity index (EPI) based on water status, temperature and PAR. Annual EPI varied throughout the agave's range of 11 states in Mexico and 2 states in the U.S. from 0.12 in the north to 0.49 in the south, reflecting primarily a threefold higher water index caused by a fourfold increase in annual precipitation to the south. The monthly water index averaged 0.30 in the dry northern region to 0.86 in the south. Productivity of agave growing in its natural range would never be greater than half of that expected under wet conditions, optimal temperatures, and saturating PAR. (Cassar-PTT)
W88-05368

**TREE RING-BASED RECONSTRUCTION OF ANNUAL PRECIPITATION IN THE SOUTH-CENTRAL UNITED STATES FROM 1750 TO 1980,**
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 2B.
W88-05541

**LEAF WATER AND CARBOHYDRATE STATUS OF VA MYCORRHIZAL ROSE EXPOSED TO DROUGHT STRESS,**
Washington State Univ., Pullman. Dept. of Horticulture and Landscape Architecture.
R. M. Auge, K. A. Schekel, and R. L. Wample.
Plant and Soil PLSOA2, Vol. 99, No. 2-3, p 291-302, 1987. 1 fig, 3 tab, 37 ref.

Descriptors: *Leaves, *Water potential, *Mycorrhizae, *Roses, *Water Stress, *Carbohydrates, *Plant Physiology, Fertilization, Drought, Chlorophyll, Starch, Water deficit, Osmotic Pressure, Ornamentals.

Shoot water relations and carbohydrate levels were compared for droughted nonmycorrhizal and vesicular-arbuscular (VA) mycorrhizal Rosa hybrida L. cv. 'Samantha' plants grown with high and low phosphorus fertilization. Leaf diffusive conductance (g sub l) of plants colonized by Glomus intraradices Schenk and Smith and Glomus deserticola Trappe, Bloss and Menge were 2 x and 1.5 x greater, respectively, than in nonmycorrhizal plants. Regardless of P fertilization, leaf osmotic and bulk water potentials were 0.5 to 1.1 MPa higher in mycorrhizal than in nonmycorrhizal plants. Leaf starch, chlorophyll and water contents were higher in G. intraradices-colonized plants than in the high-P nonmycorrhizal plants, while fructose, glucose and total soluble carbohydrates were lower. Level of P fertilization had no effect on water relations or soluble carbohydrate content of nonmycorrhizal roses. The water status of droughted rose was improved more by G. intraradices than by G. deserticola. (Author's abstract)
W88-05569

**IMPACT OF POTASSIUM, SODIUM, AND SALINITY ON THE PROTEIN-AND FREE AMINO ACID CONTENT OF WHEAT GRAIN,**
Nevada Univ., Reno. Dept. of Plant Science.
For primary bibliographic entry see Field 3C.
W88-05570

**SEASONAL CHANGES IN THE TRACE METALS IN SALT MARSH ANGIOSPERMS,**
Bielefeld Univ. (Germany, F.R.). Fakultaet fuer Biologie.
For primary bibliographic entry see Field 2L.
W88-05653

## 2J. Erosion and Sedimentation

**RUNOFF LOSSES FROM EIGHT WATERSHEDS AS INFLUENCED BY SOIL COVER CONDITION AND MANAGEMENT SYSTEMS AT EL RENO, OKLAHOMA,**
Oklahoma State Univ., Stillwater. Graduate Coll.
For primary bibliographic entry see Field 5B.
W88-05210

LAKE SEDIMENTATION REDUCTION TECHNIQUES,
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 4D.
W88-05353

OCCURRENCE OF VEGETATION ON GEOMORPHIC SURFACES IN THE ACTIVE FLOODPLAIN OF A CALIFORNIA ALLUVIAL STREAM,
Oregon State Univ., Corvallis. Dept. of Forest Science.
For primary bibliographic entry see Field 2H.
W88-05363

CONTRIBUTION OF C14 DATING TO A BETTER UNDERSTANDING OF THE POM BEHAVIOUR IN ESTUARIES,
Institut de Geologie du Bassin d'Aquitaine, Talence (France).
For primary bibliographic entry see Field 2L.
W88-05375

PROCESS-ORIENTED ESTIMATION OF SUSPENDED SEDIMENT CONCENTRATION,
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
K. N. Irvine, and J. J. Drake.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1017-1025, December 1987. 7 fig, 2 tab, 35 ref.

Descriptors: *Suspended sediments, *Sediment concentration, *Mathematical models, *Model studies, *Data interpretation, Mathematical studies, Mathematical equations, Regression analysis, Ausable River, Canada, Rivers, Seasonal variation, Ontario.

Least squares regression and ARIMA models were developed from suspended sediment data for the Ausable River, Southern Ontario, Canada. A poor correlation between discharge and suspended sediment concentration results from the dynamics of the physical system, including seasonality, antecedent conditions, and hysteresis. Regression model results were significantly improved by the division of the data into seasons and the addition of simple, but physically meaningful variables. Misleading improvements obtained from the regression of sediment load and discharge are discussed. ARIMA models provided accurate forecasts of sediment concentration on a real-time basis, but the rigorous data requirements limit their use in modeling suspended sediment concentrations in Canadian Rivers. (Author's abstract)
W88-05403

MODELING THE EFFECTS OF URBANIZATION ON BASIN WATER YIELD AND RESERVOIR SEDIMENTATION,
Agricultural Research Service, Temple, TX.
For primary bibliographic entry see Field 4C.
W88-05413

BED LOAD TRANSPORT REGIME OF A SMALL FOREST STREAM,
Forest Service, Ogden, UT. Intermountain Research Station.
R. C. Sidle.
Water Resources Research WRERAO, Vol. 24, No. 2, p 207-218, February 1988. 13 fig, 3 tab, 26 ref.

Descriptors: *Bed load, *Sediment transport, *Channel morphology, *Streamflow, *Storm flow, Seasonal variation, Riffles, Pools, Hysteresis, Hydrographs, Flow, Streams.

Bed load transport in a small gravel-bedded stream on Chichago Island, Alaska, was measured for 33 autumn storm flows during 1980 through 1985 to determine temporal and spatial trends within a riffle-pool-riffle sequence. The transport of fine sediment was more frequent than coarse sediment. Scouring of coarse material in the reach appeared to be triggered only by high flows with T sub r > or = 5 years. Within a given storm season, both antecedent storm history and cumulative flow (above the threshold for bed load transport, 0.25 cu m/sec) influenced bed load transport; however, the effects of these seasonal factors changed from year to year, presumably in response to storage and release of sediment around large organic debris upstream. Hysteresis loops existed in bed load transport versus flow plots for many storms. Fine bed load material was more subject to such differential transport over the storm hydrograph than was coarse material. During the 6-year period, both riffles scoured along most of the channel width while the middle portion of the pool filled. (Author's abstract)
W88-05435

BED LOAD TRANSPORT FLUCTUATIONS IN A GRAVEL BED LABORATORY CHANNEL,
Massachusetts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences.
R. A. Kuhnle, and J. B. Southard.
Water Resources Research WRERAO, Vol. 24, No. 2, p 247-260, February 1988. 22 fig, 7 tab, 45 ref. NSF Grant EAR 8415466.

Descriptors: *Bed load, *Sediment transport, *Gravel beds, *Flumes, *Streamflow, Channels, Sediments, Gravel, Transport, Flow, Bed load.

Flume experiments were conducted to investigate the mechanisms of transport of a gravel-sand mixture by shallow unidirectional flows. Two water recirculating sediment feed flumes were used: one with a 6 m long and 0.15 m wide channel and other with an 11 m long channel with widths of 0.74 m and 0.53 m. The sediment, poorly sorted gravel with a mean size of 3 mm, was fed at the upstream end of the channel at steady rates from 0.03 kg/sec/m to 1.0 kg/sec/m. Sediment transport rate out of the channel varied in all runs, at approximate periods of 3 min in the runs with high transport rates to 14 min in the runs with low transport rates. The runs with low transport rates also showed fluctuations in total transport rate at periods of about 25 min. Transport rates of each size fraction varied with time in a distinctive pattern in all runs. The time variations were caused by the migration of very long and low bed load sheets in the runs with low to moderate transport rates and dunelike bed forms in the run with the highest transport rate. The bed surface in all runs was coarser in size than the original sediment mix except that with the highest transport rate (run H5) in which the size distribution was nearly the same as the original. (Author's abstract)
W88-05439

TURBIDITY CURRENT ACTIVITY IN A BRITISH COLUMBIA FJORD,
Louisiana State Univ., Baton Rouge.
For primary bibliographic entry see Field 2L.
W88-05504

REAL-TIME LANDSLIDE WARNING DURING HEAVY RAINFALL,
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2A.
W88-05505

FLOW PROCESSES IN A CURVED ALLUVIAL CHANNEL,
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2E.
W88-05529

HYDROGEOCHEMICAL CYCLING AND CHEMICAL DENUDATION IN THE FORT RIVER WATERSHED, CENTRAL MASSACHUSETTS: AN APPRAISAL OF MASS-BALANCE STUDIES,
Massachusetts Univ., Amherst. Dept. of Geology and Geography.
For primary bibliographic entry see Field 2K.
W88-05535

VARIABILITY OF BED LOAD MEASUREMENT,
Colorado State Univ., Fort Collins. Dept. of Earth Resources.
For primary bibliographic entry see Field 7B.
W88-05542

TRIBUTARY RESPONSE TO LOCAL BASE LEVEL LOWERING BELOW A DAM,
Colorado State Univ., Fort Collins. Dept. of Earth Resources.
D. Germanoski, and D. F. Ritter.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 1, p 11-24, January-March 1988. 7 fig, 3 tab, 33 ref. U.S. Army Research Grant DAAG29-84-K-0189.

Descriptors: *Sedimentation, *Channel morphology, *Channel erosion, *Tributaries, *Incised rivers, *Dam effects, *Degradation, *Dendrochronology, *Sediment discharge, *Missouri, Alluvium, High flow, Root-armoring, Longitudinal profiles, Dating.

Tributaries located immediately downstream from Bagnell Dam, in central Missouri, responded to lowered local base level by incising vertically, widening, and expanding headwardly. The eight tributaries examined join the Osage River along a 17-km reach directly below the dam. These tributaries flow through unconsolidated alluvium, and respond rapidly to base level lowering. Local base level lowering below Bagnell Dam is believed to result from a combination of factors, including an increase in channel cross-sectional area caused by degradation and channel widening and hydrological desynchronization of the trunk river and the tributaries during periods of high discharge. Of these, degradation appears to be the most important cause of tributary incision. Age dates from cores of trees which project cross-channel roots indicate that the tributary entrenchment has occurred after the closure of Bagnell Dam in 1931. Root-armored knickpoints, subaerially exposed cross-channel tree roots, broken-off roots, and 'within channel' terraces provided the basis for reconstruction of relative pre-entrenchment tributary profiles which, when extended to the Osage River confluence, reveals the magnitude of entrenchment at the tributary mouth. The tributaries incised on average, 2.2 m and widened approximately 2.3 m at their mouths. Root armoring protracts the adjustment period of the tributaries and results in stepped longitudinal profiles. Tributary incision is episodic, and the influxes of high sediment discharge are out of phase from tributary to tributary. (Author's abstract)
W88-05550

NITROGEN GAS SUPERSATURATION IN THE RECENT SEDIMENTS OF LAKE ERIE AND TWO POLLUTED HARBORS,
Wright State Univ., Dayton, OH. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W88-05594

CORPUS CHRISTI INNER HARBOR SHOALING INVESTIGATION,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 2L.
W88-05713

NOTES ON SEDIMENTATION ACTIVITIES, CALENDAR YEAR 1986.
Geological Survey, Reston, VA. Office of Water Data Coordination.
Office of Water Data Coordination, 417 National Center, Reston, VA. 22092. September 1987. 229 p.

Descriptors: *Sedimentation, *Information exchange, *National Water Data Exchange, Literature review, Research priorities, Laboratory studies.

This report is a digest of information furnished by Federal agencies conducting sedimentation investigations. Descriptions of work in progress or planned are included in the report, as well as

important findings, new methods, new publications, information relating to laboratory and research activities, and other pertinent information. The material is organized by major drainage regions in the conterminous United States, Alaska, Hawaii, and the Caribbean. Until 1979, each issue of this publication contained a list of stations where sediment data are collected, giving the station location, drainage area, and other related information. Because the station list did not change significantly from year to year, it was eventually deleted from the publication. Also, because most users of the station list were only interested in the stations in a certain geographic area, it was felt that their needs could be served more efficiently by acquiring the necessary information through the National Water Data Exchange (NAWDEX). Therefore, locations and addresses of NAWDEX assistance centers are included in this report. (Lantz-PTT)
W88-05745

**OVERVIEW OF CONSERVATION TILLAGE,**
Purdue Univ., Lafayette, IN.
For primary bibliographic entry see Field 3F.
W88-05760

**OVERVIEW OF RURAL NONPOINT POLLUTION IN THE LAKE ERIE BASIN,**
Heidelberg Coll., Tiffin, OH.
For primary bibliographic entry see Field 5B.
W88-05763

**HYDRAULIC PROCESSES ON ALLUVIAL FANS,**
Nevada Univ. System, Las Vegas. Water Resources Center.
R. H. French.
Elsevier, Amsterdam, The Netherlands. 1987. 244 p.

Descriptors: *Sediment transport, *Alluvial fans, *Sedimentation, *Sedimentary structures, *Hydraulic processes, Geohydrology, Geology, Hydraulic engineering, Sediment transport, Model studies, Channel flow.

A comprehensive understanding of hydraulic processes on alluvial fans requires some knowledge and expertise in the academic disciplines of geomorphology, hydrometeorology, hydrology, geohydrology, and hydraulic engineering. This book only discusses the geologic and hydraulic engineering aspects of the subject because the other aspects are adequately treated in existing books. To this end, the book is arranged as follows. In Chapter 2, the relevant geologic aspects of alluvial fans are discussed. This is a summary chapter intended to familiarize the reader with the aspects of geology important to the subject. Chapter 3 summarizes the basic principles of open-channel hydraulics, sediment transport, and debris flows. In Chapter 4, the information and data presented in Chapters 2 and 3 are combined to discuss the models, both physical and numerical and on both geologic and engineering time scales, which have been used to study hydraulic processes on alluvial fans. Chapter 5 discusses various analytic methodologies that can be used to assess flood hazard on alluvial fans. Chapter 6, the concluding chapter, discusses present and future plans for the development of urban areas on alluvial fans. (Lantz-PTT)
W88-05777

**GLACIO-FLUVIAL SEDIMENT TRANSFER: AN ALPINE PERSPECTIVE.**
John Wiley and Sons, New York, New York. 1987. 524 p. Edited by A. M. Gurnell and M. J. Clark.

Descriptors: *Sediment transport, *Glacial sediments, *Fluvial sediments, *Alpine regions, Geohydrology, Sedimentation, Catchment basins, Sediment distribution.

This book provides a structured assessment of glacial and fluvial processes in alpine glacierized drainage basins in terms of their relationship to the supply, transport and deposition of sediment. In particular, it develops an integrated approach to glacio-fluvial sediment transfer in alpine areas as a research framework, and synthesizes the worldwide status of sediment research in alpine glacierized catchments. The first section of the book considers the glacio-fluvial sediment system as a whole, its global variations and the nature of the alpine sediment system. Two sections examine the glacial and fluvial elements of sediment transfer, respectively. Each of the sections introduces the character of the sediment transfer processes, considers these in detail and concludes with a general evaluation of the group of processes at both the regional and global scales. The concluding section analyses the implications of glacio-fluvial sediment transfer in alpine drainage basins. (See W88-05785 thru W88-05801) (Lantz-PTT)
W88-05784

**ALPINE SEDIMENT SYSTEM: A CONTEXT FOR GLACIO-FLUVIAL PROCESSES,**
Southampton Univ. (England). Dept. of Geography.
M. J. Clark.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 9-31, 4 fig, 2 tab, 44 ref.

Descriptors: *Alpine regions, *Glacial sediments, *Sedimentation, *Fluvial sediments, *Sediment transport, Slope stability, Slopes, Geohydrology, Mountains, Erosion, Geology, Climate, Elevation, Temporal variation, Model studies.

The glacio-fluvial sediment system is part of the larger and more complex alpine sediment system which incorporates slope processes as well as glacial and fluvial components. Although distinct boundaries are difficult to designate, it is clear that this sediment system can be studied meaningfully at a number of scales from the sub-continental to the individual small catchment or slope. The controlling factors on the geomorphological processes include latitude, altitude, biology, pedology and geology - all but the last having some climatic implication. These factors vary in relative and absolute importance, depending on the scale of study, and induce extremely important spatial variations which render the concept of a single alpine sediment system suspect. The same is true of temporal variations, again at a variety of scales. Indeed, the reconceptualization and recalibration of time-based models of the system or its components in recent years represent one of the most exciting aspects of the subject at the present time. (See also W88-05784) (Author's abstract)
W88-05785

**GEOCRYOLOGICAL INPUTS TO THE ALPINE SEDIMENT SYSTEM,**
Southampton Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2C.
W88-05786

**SEDIMENT TRANSFER PROCESSES IN ALPINE GLACIER BASINS,**
Worcester Coll., Oxford (England). Dept. of Geography.
C. R. Fenn.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 59-85, 4 fig, 4 tab, 86 ref.

Descriptors: *Weathering, *Sediment transport, *Alpine regions, *Glacier basins, Glacial sediments, Erosion, Denudation, Catchment areas, Sediment load, Model studies, Hydrologic models, Hydrographs, Flow discharge, Diurnal variation.

An overview of the sediment production and routing processes operating in glacierized alpine drainage basins, is provided. Information relating to sediment source areas, production processes and transport pathways is summarized in tabular and diagrammatic form, and the transfer system is expressed in balance terms. The interdependency between in situ physical and chemical weathering processes and moving ice, water and debris mass erosive processes is highlighted, as is the spatial and temporal variability of sediment transfer. The outflow stream is considered to be the sole means of conveying sediment out of the basin. The basic characteristics of solute, suspended and bed load transport in proglacial streams are outlined, and are incorporated into a flow-based model of sediment transport in glacial outflow stream systems. The model attempts to draw together the following: (1) Time-space changes in diurnal input hydrograph form; (2) Temporal changes in the form of diurnal outflow hydrographs; (3) The resulting quickflow and delayed flow components of the proglacial discharge time series; (4) The associated solute concentration (electrical conductivity) characteristics of the streamflow record; and (5) The pattern of sediment transport associated with the streamflow record. The models are clearly normative. Departures from the responses indicated may result from the operation of other water/solute/sediment supply and routing mechanism (only the simplest are incorporated in the model shown). The value of such models lies in the identification of dissimilarities as well as similarities with 'real' records (e.g., in the timing, number, size and shape of fluctuations). (See also W88-05784) (Lantz-PTT)
W88-05787

**HYDROGEOMORPHOLOGY OF ALPINE PROGLACIAL AREAS,**
Southampton Univ. (England). Dept. of Geography.
K. J. Gregory.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 87-107, 3 fig, 2 tab, 56 ref.

Descriptors: *Geohydrology, *Geomorphology, *Alpine regions, *Glacier basins, *Sediment transport, Sedimentation, Channel flow, Fluvial sediments, River flow, River training, Time scales, Proglacial environments.

Fluvial processes in alpine proglacial areas reflect an unusual combination of discharge variations, which are variable at several temporal scales, of sediment characteristics which are often not supply-limited and of local characteristics where slope is especially variable. Against the background of these controls three broad domains can be identified: (1) sandur with braided channel patterns; (2) bedrock domains; and (3) areas dominated by paleoforms. Analysis of recent changes has not been able to utilize the general paleohydrologic approaches which apply in other areas, but interpretations based on the use of sedimentary characteristics to develop paleohydraulic approaches offer considerable potential. The fluvial system of alpine proglacial areas is characterized by a number of distinctive attributes of which two, namely high stream power values and sensitivity in relation to threshold conditions, are particularly evident. In such areas, ample evidence of recent fluvial changes can be developed by the techniques of paleohydrology and paleohydraulics to furnish useful data on late Quaternary change. In addition, such techniques could usefully provide an input to the future of alpine proglacial systems and particularly to the management of river courses in such areas. In environments elsewhere, it has been advocated by a number of researchers that management strategies can be more effective overall if they work 'with' the river rather than 'against' it. Although there are problems of applying such a philosophy to high-energy gravel bed proglacial river channels, nevertheless there is considerable scope for modification of existing procedures to retain some of the characteristics of the alpine proglacial river environment when the river channel is managed and controlled. (See also W88-05784) (Lantz-PTT)
W88-05788

**ENGLACIAL AND SUPRAGLACIAL SEDIMENT: TRANSPORT AND DEPOSITION,**
Southampton Univ. (England). Dept. of Geography.
R. J. Small.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 111-145, 16 fig, 2 tab, 10 ref.

Descriptors: *Sediment transport, *Glacial sediments, *Sedimentation, Particle size, Particle shape, Sediment classification, Glaciology, Case studies, Switzerland, Moraines, Glacial drift.

Following a brief review of glacial sediment transport, by way of supraglacial, englacial and subglacial pathways, the principal characteristics of glacial sediment, in terms of clast shape and roundness and particle size distribution related to modes of origin, are critically examined. The occurrence of sediment within alpine glaciers, either in dispersed form or as longitudinal debris septa and transverse sediment concentrations, is discussed, together with possible modes of sediment incorporation (sedimentary layering in the accumulation zone, incorporation via open crevasses, transference from the glacier base by upward-turning flow lines or thrust faulting and the formation of anticlinal ice structures by longitudinal or transverse glacier compression). Case studies of englacial sediment within three Swiss glaciers (Glacier de Tsidjiore Nouve, Bas Glacier d'Arolla and Haut Glacier d'Arolla) are presented. Finally, a general consideration of the role of englacial debris in the formation of supraglacial moraines (medial and lateral) is followed by a discussion of moraine form and genesis in relation to the three Swiss glaciers, and a brief examination of the problem of moraine classification. (See also W88-05784) (Author's abstract)
W88-05789

**SUBGLACIAL SEDIMENT SYSTEM,**
Universite Libre de Bruxelles (Belgium). Lab. de Geomorphologie.
R. A. Souchez, and R. D. Lorrain.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 147-164, 5 fig, 41 ref.

Descriptors: *Glacial sediments, *Subglacial sediments, *Sediment transport, *Glaciers, Alpine regions, Basal ice layer, Ice, Snowmelt, Chemical analysis, Debris, Channel flow, Suspended sediments.

Processes by which sediments are produced, incorporated and transported at the base of alpine glaciers are discussed. The main theme is the detailed study of the basal ice layer (BIL), which plays a prominent role not only in transferring debris at the glacier base down-glacier but also as an effective tool for glacier abrasion. The mechanisms responsible for the formation of this BIL are discussed in the light of chemical and isotopic analyses of the constituting ice. Present-day sediment transfer and glacier erosion at the base of alpine glaciers are dependent on the two main processes. First, the formation of a basal ice layer by phase changes at the ice-rock interface is likely to incorporate debris into the glacier. Abrasion is dependent on the presence and concentration of debris at the glacier sole. If, because of changing conditions at the interface, the basal ice layer is partially melted, then it may act as an abrasive ice layer. The result is debris comminution and bedrock erosion. The debris formed may itself be later incorporated in the ice, once released by melting, and so on. This is an efficient means of subglacial sediment production and transfer. The second main process is the role of meltwater that reaches the bed and is confined to conduits and channels. This water exports debris lying on the bed and, because of the transport of such debris mainly in suspension, is able to 'carve' the glacial bed. (See also W88-05784) (Lantz-PTT)
W88-05790

**MORAINE SEDIMENT BUDGETS,**
Southampton Univ. (England). Dept. of Geography.
R. J. Small.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 165-197, 12 fig, 4 tab, 27 ref.

Descriptors: *Moraines, *Glacial sediments, *Sediment load, *Denudation, Glacial drift, Sedimentation, Alpine regions, Norway, Baffin Island, Colorado, Case studies, Glaciers, Sediment transport, Suspended sediments, Bed-load discharge, Switzerland.

The implications of large Neoglacial dump moraines for rates of sediment transport and deposition by alpine glaciers are briefly stated. Studies of sediment output, based mainly on the dimensions and age of moraines and measurements of suspended sediment load in proglacial streams, are presented for selected glaciers in Baffin Island, Norway and Colorado, and the problems of inferring rates of glacial erosion from such evidence are examined critically. A detailed study of the sediment budget of the Glacier de Tsidjiore Nouve, Switzerland, is preceded by a general review of the form, origin and sedimentological characteristics of lateral moraines. The Tsidjiore Nouve study is based primarily on the inference of past and present rates of sediment accumulation on massive Neoglacial moraine embankments, related to a series of minor glacial advances from ca. 5000 yr BP. Techniques for determining the origin of this sediment (from glacial erosional processes or supraglacial rockwall weathering) are presented and employed in the analysis. In addition, detailed field monitoring of suspended sediment and bed load transport by the proglacial stream from the Glacier de Tsidjiore Nouve has been made for 1981 and 1982. A provisional sediment budget for the Glacier de Tsidjiore Nouve is calculated; this indicates: (1) the considerable relative importance of supraglacial sediment inputs in the recent past and at present; and (2) a high overall rate of geomorphological activity, evidenced by an 'erosion rate' for the glacier catchment as a whole of 1.55-2.29 mm/yr. (See also W88-05784) (Author's abstract)
W88-05791

**GLACIAL SEDIMENT SYSTEM: AN ALPINE PERSPECTIVE,**
Southampton Univ. (England). Dept. of Geography.
R. J. Small.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 199-203, 11 ref.

Descriptors: *Glacial sediments, *Alpine regions, *Sediment transport, Moraines, Glacial drift, Colorado, Glaciology, Glaciers, Erosion, Deglaciation.

It is proposed, on the basis of the large size of Neoglacial latero-frontal dump moraines and measurements of supraglacial and englacial sediment, that at present supraglacial sediment sources are of particular importance in alpine environments. This reflects changes in glacier basin configuration in the post-Wurm period, leading to a greater incidence of rock falls and more effective gelifraction. Some conflicting evidence (e.g. from the Front Range, Colorado) is also presented and discussed. Although further quantitative studies of sediment transport by glaciers are needed before anything like a comprehensive picture can be obtained, the following interim conclusions can be drawn. (1) When viewed purely as sediment transport systems polar, sub-polar and temperate glaciers may not behave in inherently different ways - although there may be significant variations in rates of sediment production and even mechanisms of erosion (with abrasion possibly being more effective than plucking in temperate glaciers). (2) The balance between supraglacial, englacial and subglacial sediment transport is largely a function of catchment morphological variables (presence or absence of valley walls, headwalls and nunataks, which are in turn related to the extent of glacierization). Where significant changes have occurred over a period of time (as in the post-Wurm deglaciation of the Alps) it is inevitable that supraglacial sediment inputs, and thus supraglacial and englacial transport, are substantially altered. (See also W88-05784) (Lantz-PTT)
W88-05792

**SUSPENDED SEDIMENT,**
Southampton Univ. (England). Dept. of Geography.
A. M. Gurnell.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 305-354, 13 fig, 5 tab, 78 ref.

Descriptors: *Glaciohydrology, *Proglacial streams, *Suspended sediments, *Glacial streams, *Sediment transport, Sediment discharge, Catchment areas, Stream discharge, Comparison studies, Sediment load, Glaciers.

The characteristics of suspended sediment transport in proglacial streams are considered. A description of the techniques and sampling designs employed to study the suspended sediment concentration of proglacial streams is followed by an analysis of data from 43 glacierized catchments to identify the main catchment characteristics which influence their suspended sediment yield. The remainder of the paper considers, in increasing detail, the nature and controls of suspended sediment transport in proglacial streams including the relationship between stream discharge and suspended sediment concentration, the anomalies from such a relationship, spatial aspects of suspended sediment delivery to the proglacial stream network, the role of proglacial sediment sources and sinks in influencing suspended sediment yield and the particle size characteristics of proglacial suspended sediment. (See also W88-05784) (Author's abstract)
W88-05795

**BEDLOAD,**
Oxford Univ. (England). Geography School.
B. Gomez.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 355-376, 1 fig, 151 ref.

Descriptors: *Bed load, *Sediment transport, *Channels, *Bed-load discharge, *Stream discharge, Sediment load, Mountain streams, Alpine regions, Channel flow, Comparison studies, Unsteady flow, Energy gradient.

This review initially considers the development of sampling and measuring devices which are appropriate for use in gravel bed channels, the findings of recent investigations into bedload transport dynamics in gravel-bed rivers as a whole and their bearing on attempts which have been made to predict bedload discharge. Finally, specific attention is paid to mountain rivers and the degree to which the bedload transport in this environment conforms with observations on sediment movement in gravel-bed rivers in general is assessed. It is found that the inherent unsteadiness which is characteristic of the bedload transport process in lowland stream channels appears to be accentuated by factors such as the presence of step-pool sequences in steep channels and the dependence of bedload yields on the supply of sediment to the stream channel. These and other factors, such as the enhanced form resistance which is characteristic of these channels, pose additional problems when attempts are made to calculate sediment transport rates in mountain rivers. Consequently, existing bedload transport equations appear to be even more unreliable when they are applied to mountain rivers. Differences in energy distribution and sediment supply cause mountain streams to behave differently from their lowland counterparts. A knowledge of bedload transport dynamics in mountain streams is, therefore, crucial to the understanding of the bedload transport as a whole. Of particular interest, for example, is the extent to which the transport of bedload is dependent on sediment supply in mountain rivers. (See also W88-05784) (Lantz-PTT)
W88-05796

**FLUVIAL SEDIMENT YIELD FROM ALPINE, GLACIERIZED CATCHMENTS,**
Southampton Univ. (England). Dept. of Geography.
A. M. Gurnell.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 415-420, 1 tab, 4 ref.

Descriptors: *Glaciohydrology, *Sediment load, *Glacial streams, *Glacial sediments, *Fluvial sediments, *Alpine regions, *Sediment yield, Sediment transport, Sediment load, Stream discharge, Catchment areas.

Presented is a discussion of the components of fluvial sediment transport from glacierized catchments that considers three main themes: the problems of specifying and quantifying components of the total fluvial sediment load in alpine proglacial streams; the relative importance of each of the components of the sediment load in the alpine context; and the generation of sediment yield from alpine glacierized drainage basins. (See also W88-05784) (Lantz-PTT)
W88-05798

**PROGLACIAL CHANNEL PROCESSES,**
Worcester Coll., Oxford (England). Dept. of Geography.
C. R. Fenn, and A. M. Gurnell.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 423-472, 24 fig, 51 ref.

Descriptors: *Sediment transport, *Proglacial streams, *Channel morphology, *Braided streams, *Glacial streams, *Channels, *Channel flow, Alpine regions, Flow rates, River channels, Proglacial environments, Valley trains, Sandur environments, Flow patterns, Spatial variation.

Proglacial channel processes within alpine proglacial (valley train) environments, although studies of these zones are set within the broader context of studies of the continuum of sandur environments from broad sandur plains to very confined valley trains, are emphasized in this discussion. Specific emphasis is placed on the rates and modes of river channel adjustment in planform and in cross-section in proglacial valley train environments rather than the sedimentary consequences of such adjustments. Four main themes are considered: the nature of constraints which differentiate valley train from sandur plain processes; channel braiding processes; adjustments in proglacial channel pattern at a range of spatial and temporal scales; and the interactions between proglacial braided channel form and size and the transmitted discharge and sediment regime. In summarizing the nature of morphological adjustments, it is clear that changes in the form of proglacial channels: (1) occur in pattern, profile and in section; (2) occur over a range of timescales, from the secular to the hourly; (3) occur over a range of spatial scales, from the network to the section; (4) occur frequently and are achieved rapidly; (5) vary from the large to the small, and from the 'permanent' to the transient; and (6) vary from local adjustments around an equilibrium form to large-scale alterations in status. (See also W88-05784) (Lantz-PTT)
W88-05799

**GLACIAL MELTWATER STREAMS, HYDROLOGY AND SEDIMENT TRANSPORT: THE CASE OF THE GRANDE DIXENCE HYDROELECTRICITY SCHEME,**
Grande Dixence Societe Anonyme, Sion (Switzerland).
For primary bibliographic entry see Field 2E.
W88-05800

**GLACIO-FLUVIAL SEDIMENT SYSTEM: APPLICATIONS AND IMPLICATIONS,**
Southampton Univ. (England). Dept. of Geography.
M. J. Clark.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 499-516, 4 tab, 46 ref.

Descriptors: *Glaciohydrology, *Glacial sediments, *Fluvial sediments, *Sediment transport, Erosion, Weathering, Alpine regions, Research priorities, Sedimentation, Geohydrology.

Sediment system studies have wide applicability, but four focuses which typify present concerns are the contemporary processes, the use of sediment budgets to estimate weathering or erosion rates, the renewed emphasis on paleoenvironmental reconstruction and modelling and the practical uses of alpine sediment system studies. Each of these topics represents an important field of application, but each also raises issues which are of relevance to any assessment of the current status of research on the glacio-fluvial sediment system. In particular, the methodological and technical constraints pertinent to such studies are a major influence on their investigative design and validity, and are consequently accorded specific consideration. (See also W88-05784) (Author's abstract)
W88-05801

**ERODING SOILS: THE OFF-FARM IMPACTS,**
Conservation Foundation, Washington, DC.
E. H. Clark, J. A. Haverkamp, and W. Chapman.
The Conservation Foundation, Washington, DC. 1985. 252 p.

Descriptors: *Soil erosion, *Environmental effects, *Farming, *Soil conservation, Agriculture, Geohydrology, Water pollution control, Sedimentation, Path of pollutants, Fertilizers, Pesticides, Silting, Reservoir silting, Economic aspects.

In addition to its impacts on agricultural land productivity and crop yields, soil erosion takes a major toll off the farm: waterways polluted by sediment, fertilizers, and pesticides; accelerated siltation of reservoirs and lakes; destruction of breeding grounds for fish and other aquatic life; increased costs for dredging harbors; siltation in rivers leading to increased flooding; and so on. These impacts off the farm have largely been ignored by government and, until now, by the research community. A comprehensive analysis of these problems includes a review of the chemical, physical, hydrological, and ecological principles essential to understanding how eroding soils cause different types of impacts off the farm. The magnitude of the problems is assessed and a tally and analysis of their estimated economic impacts, about $6 billion a year in 1980 dollars is provides. The effectiveness of current techniques for controlling runoff from agricultural lands and ways to help target federal soil conservation expenditures to mitigate the most severe problems are discussed. (Lantz-PTT)
W88-05845

**SEDIMENT RESPONSES DURING STORM EVENTS IN SMALL FORESTED WATERSHEDS,**
Royal Military Coll., Duntroon (Australia). Dept. of Geography.
W. A. Rieger, and L. J. Olive.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 490-498, 2 fig, 6 ref.

Descriptors: *Sediment load, *Forest watersheds, *Storms, *Water quality, Suspended solids, Model studies, Spectral analysis, Temporal variation, Spatial variation.

Measurements of suspended sediment concentration and discharge during storm events were examined to determine the possible patterns in sediment response to flow in five small forested watersheds. The examination of sediment response was carried out in two contexts: (1) The response of suspended sediment to total discharge (baseflow and quickflow or stormflow), or in the framework commonly used for sediment prediction modelling; and (2) The response of suspended sediment to quickflow, where quickflow is postulated as a possible mechanism of sediment delivery to the channel. In both contexts, hysteresis diagrams were first used to determine the broad patterns between suspended sediment concentration and flow in the time domain. Results indicate that seven different response types are operating in the watersheds. Spectral analysis was then used on the storm event data in an attempt to isolate possible factors which may be causing the different response types. The temporal and spatial variations operating in the watersheds have important implications for both the design of monitoring networks and the associated water sampling techniques; and for the commonly used linear predictive methods of estimating sediment loads. (See also W88-05862) (Author's abstract)
W88-05899

## 2K. Chemical Processes

**EXPECTED PH FOR HALVING SULFATE IN ADIRONDACK RAIN,**
Systech Engineering, Inc., Lafayette, CA.
For primary bibliographic entry see Field 5B.
W88-05161

**MECHANISM OF METAL REMOVAL IN ACTIVATED SLUDGE,**
Teesside Polytechnic, Middlesbrough (England). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W88-05167

**EFFECT OF TEMPERATURE ON OXYGEN TRANSFER - LABORATORY STUDIES,**
North Carolina State Univ., Raleigh. Dept. of Civil Engineering.
A. C. Chao, D. S. Chang, C. Smallwood, and W. S. Galler.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 1089-1101, October 1987. 7 fig, 2 tab, 23 ref.

Descriptors: *Temperature effects, *Reaeration, *Oxygen transfer, *Dissolved oxygen, *Mathematical studies, Equations, Surface area, Flow, Turbulence.

Results of laboratory studies on the effect of temperature on surface oxygen transfer are presented. The measured K sub 2 (reaeration coefficient) values are calculated based on the DO response curves while predicted K sub L (oxygenation transfer coefficient) or K sub 2 values are calculated using the equation proposed by O'Connor and Dobbins for the experimental conditions. Both the measured and the predicted K sub 2 values indicate that an increasing K sub 2-temperature relationship is observed when the flow velocity is maintained at 2.8 cm/s. Using the same reaeration equipment and methodology, and with the flow velocity reduced to 1.3 cm/s, the K sub 2-temperature curve shows an initial increasing but then decreasing relationship versus temperature. When the flow velocity is decreased to 0.8 cm/s, the K sub 2-temperature displays a decreasing tendency with increasing temperature. Results obtained in this experiment support the writers' interpretation of the O'Connors and Dobbins equation and demonstrate that the surface oxygen transfer decreases for increasing temperature under conditions of low turbulence. (Author's abstract)
W88-05168

**EFFECT OF AL(III) AND SULFATE ION ON FLOCCULATION KINETICS,**
Shipley Co., Inc., Newton, MA.
For primary bibliographic entry see Field 5D.
W88-05170

**ESTIMATING CHEMICAL DOSES FOR WATER STABILIZATION,**
Auburn Univ., AL. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W88-05176

**MOLECULAR WEIGHT EFFECTS ON THM CONTROL BY COAGULATION AND ADSORPTION,**
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
For primary bibliographic entry see Field 5F.
W88-05178

**RATE OF HUMIC SUBSTANCE UPTAKE DURING ACTIVATED CARBON ADSORPTION,**
Karlsruhe Univ. (Germany, F.R.). Engler-Bunte Inst.
For primary bibliographic entry see Field 5F.
W88-05184

**FORMATION AND FATE OF FERMENTATION PRODUCTS IN HOT SPRING CYANOBACTERIAL MATS,**
Montana State Univ., Bozeman. Dept. of Microbiology.
K. L. Anderson, T. A. Tayne, and D. M. Ward.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 10, p 2343-2352, October 1987. 7 fig, 5 tab, 49 ref. NSF Grant DEB-8023341.

Descriptors: *Chemical reactions, *Hot springs, *Springs, *Fermentation, *Cyanobacteria, Octopus Spring, Yellowstone National Park, Aerobic conditions, Anaerobic conditions, Bacteria, Methanogenesis, Fatty acids, Acetates, Lactates, Propionates, Butyrates, Ethyl alcohol, Metabolism, Degradation, Aquatic habitats, Habitats, Photosynthesis, Chloroflexus aurantiacus, Bacterial mats.

The fate of representative fermentation products (acetate, propionate, butyrate, lactate, and ethanol) in hot spring cyanobacterial mats was investigated. The major fate during incubations in the light was photoassimilation by filamentous bacteria resembling Chloroflexus aurantiacus. Some metabolism of all compounds occurred under dark aerobic conditions. Under dark anaerobic conditions, only lactate was oxidized extensively to carbon dioxide. Extended preincubation under dark, anaerobic conditions did not enhance anaerobic catabolism of acetate, propionate, or ethanol. Acetogenesis of butyrate was suggested by the hydrogen sensitivity of butyrate conversion to acetate and by the enrichment of butyrate-degrading acetogenic bacteria. Accumulation of fermentation products which were not catabolized under dark anaerobic conditions revealed their importance. Acetate and propionate were the major fermentation products which accumulated in samples collected at temperatures ranging from 50 to 70 C. Other organic acids and alcohols accumulated to a much lesser extent. Fermentation occurred mainly in the top 4 mm of the mat. Exposure to light decreased the accumulation of acetate and presumably of other fermentation products. The importance of interspecies hydrogen transfer was investigated by comparing fermentation product accumulation at a 65 C site, with naturally high hydrogen levels, and a 55 C site, where active methanogenesis prevented significant hydrogen accumulation. There was a greater relative accumulation of reduced products, notably ethanol, in the 65 C mat. (Author's abstract)
W88-05188

**PRODUCTION AND FATE OF METHYLATED SULFUR COMPOUNDS FROM METHIONINE AND DIMETHYLSULFONIOPROPIONATE IN ANOXIC SALT MARSH SEDIMENTS,**
State Univ. of New York at Stony Brook. Marine Sciences Research Center.
For primary bibliographic entry see Field 2L.
W88-05191

**GROUNDWATER/LAKE DYNAMICS AND CHEMICAL EVOLUTION IN A SANDY SILICATE AQUIFER IN NORTHERN WISCONSIN,**
Wisconsin Univ., Madison. Dept. of Geology.
For primary bibliographic entry see Field 2H.
W88-05203

**REGIONAL WATER AVAILABILITY AND GLOBAL CLIMATIC CHANGE: THE HYDROLOGIC CONSEQUENCES OF INCREASES IN ATMOSPHERIC CARBON DIOXIDE AND OTHER TRACE GASES,**
California Univ., Berkeley. Energy and Resources Group.
For primary bibliographic entry see Field 5C.
W88-05216

**DEVELOPMENT AND EVALUATION OF ANALYTICAL PROCEDURES FOR BROAD SPECTRUM ANALYSIS OF SYNTHETIC ORGANIC CHEMICALS IN SOURCE AND FINISHED DRINKING WATERS,**
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 5A.
W88-05223

**GROUNDWATER, IRON AND MANGANESE: AN UNWELCOME TRIO,**
HKM Associates, Billings, MT.
For primary bibliographic entry see Field 5F.
W88-05350

**ATOMIC ABSORPTION SPECTROMETRIC DETERMINATION OF TRACE COPPER IN WATER BY SORPTION ON AN ION-EXCHANGE RESIN AND DIRECT ATOMIZATION OF THE RESIN,**
Rikkyo Univ., Tokyo (Japan). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W88-05359

**DETERMINATION OF TRACE SULFIDES IN TURBID WATERS BY GAS DIALYSIS/ION CHROMATOGRAPHY,**
Alberta Environmental Centre, Vegreville.
For primary bibliographic entry see Field 5A.
W88-05360

**INFLUENCE OF BROMIDE ION ON ORGANIC CHLORINE AND ORGANIC BROMINE FORMATION DURING FREE CHLORINATION,**
Houston Univ., TX. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W88-05387

**COMMITTEE REPORT: RESEARCH NEEDS FOR THE TREATMENT OF IRON AND MANGANESE,**
For primary bibliographic entry see Field 5F.
W88-05388

**TECHNICAL NOTE: PROPER USE OF THE UNIT MG AS CACO3/L,**
Auburn Univ., AL. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W88-05389

**GEOCHEMISTRY OF GROUNDWATER IN TERTIARY AND CRETACEOUS SEDIMENTS OF THE SOUTHEASTERN COASTAL PLAIN IN EASTERN GEORGIA, SOUTH CAROLINA, AND SOUTHEASTERN NORTH CAROLINA,**
Geological Survey, Nashville, TN.
R. W. Lee, and D. J. Strickland.
Water Resources Research WRERAO, Vol. 24, No. 2, p 291-303, February 1988. 10 fig, 6 tab, 19 ref, append.

Descriptors: *Geochemistry, *Groundwater, *Water chemistry, *Aquifers, *Ions, Salts, Organic matter, Minerals, Georgia, South Carolina, North Carolina, Brines.

Geochemical samples of groundwater taken along hydrologic flow paths in eastern Georgia, South Carolina, and southeastern North Carolina, from noncalcareous sand aquifers, largely of Cretaceous age, are dominated by sodium and bicarbonate ions. Calcareous sand aquifers, largely of Tertiary age, contain water whose chemistry is dominated by calcium and bicarbonate ions, but may evolve downgradient to sodium and bicarbonate dominance. Water chemistry in both types of aquifer evolves to sodium chloride dominance as a result of fresh water mixing with subsurface brines or seawater present in the deeper downgradient parts of the aquifers. Principal aqueous chemical reactions appear to occur in five reaction zones in the aquifers and include feldspar hydrolysis to kaolinite, calcite dissolution, calcium-for-sodium cation exchange, and neoformation of sodium smectite in the downgradient parts of the aquifers. Redox reactions produce dissolved iron concentrations greater than 1 mg/L near the recharge areas. Organic matter in the aquifers is oxidized to CO2 by iron reduction and sulfate reduction processes. Production of CO2 by a methanogenic process may also occur. Geochemical mass-transfer models simulating the observed chemistry in western Alabama and eastern Mississippi have been extended to account for higher concentrations of sodium and bicarbonate observed in the South Carolina part of the aquifers. (Author's abstract)
W88-05443

**THEORY ON THE MECHANISMS REGULATING THE BIOAVAILABILITY OF MERCURY IN NATURAL WATERS,**
Bohlin and Stromberg A.B., Solna (Sweden).
For primary bibliographic entry see Field 5B.
W88-05466

**EXPERIMENTAL MEASUREMENTS AND COMPUTER PREDICTIONS OF COPPER COMPLEX FORMATION BY SOLUBLE SOIL ORGANIC MATTER,**
Rothamsted Experimental Station, Harpenden (England). Dept. of Soils and Plant Nutrition.
For primary bibliographic entry see Field 5B.
W88-05467

**SPREADING OF OIL ON WATER IN THE SURFACE-TENSION REGIME,**
Washington Univ., Seattle. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W88-05474

**DISULFATE ION AS AN INTERMEDIATE TO SULFURIC ACID IN ACID RAIN FORMATION,**
Lawrence Berkeley Lab., CA. Applied Science Div.
For primary bibliographic entry see Field 5B.
W88-05502

**CHEMISTRY AND FATE OF AL(III) IN TREATED DRINKING WATER,**
Syracuse Univ., NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W88-05508

**EFFECTS OF THE BRACKISH DEPOSIT-FEEDING POLYCHAETES NOTOMASTUS SP. (CAPITELLIDAE) AND NEANTHES JAPONICA (IZUKA) (NEREIDAE) ON SEDIMENTARY O2 CONSUMPTION AND CO2 PRODUCTION RATES,**
Tohoku Univ., Sendai (Japan). Biological Inst.
For primary bibliographic entry see Field 2L.
W88-05513

**MORE ON MECHANISM AND SOME IMPORTANT PROPERTIES OF CHROMATE ION EXCHANGE,**
Lehigh Univ., Bethlehem, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W88-05515

**HYDROGEOCHEMICAL CYCLING AND CHEMICAL DENUDATION IN THE FORT RIVER WATERSHED, CENTRAL MASSACHUSETTS: AN APPRAISAL OF MASS-BALANCE STUDIES,**
Massachusetts Univ., Amherst. Dept. of Geology and Geography.
R. F. Yuretich, and G. L. Batchelder.
Water Resources Research WRERAO, Vol. 24, No. 1, p 105-114, January 1988. 7 fig, 4 tab, 37 ref. Department of the Interior Project WR-138.

Descriptors: *Weathering, *Chemical weathering, *Streams, *Chemical properties, *Hydrogeochemistry, *Chemical denudation, *Groundwater movement, *Geochemistry, Geohydrology, Fort River Watershed, Massachusetts, Hubbard Brook, New Hampshire, Comparison studies, Hydrogen ion concentration, Total dissolved solids, Surficial cover, Groundwater, Watersheds, Surface runoff, Cation removal, Cations, Weathering, Silica, Silica removal.

The Fort River watershed in central Massachusetts receives precipitation with a composition similar to that in Hubbard Brook (New Hampshire), yet the average stream water chemistry is substantially

different, showing higher pH and total dissolved solids. This is largely a function of bedrock and surficial geology, and chemical differences among small streams within the Fort River watershed are apparently controlled by the composition and thickness of the prevailing surficial cover. The surficial deposits determine groundwater and surface water flow paths, thereby affecting the resultant contact time with mineral matter and the chemistry of the runoff. Despite the rural setting, over 95% of the annual sodium and chloride in the streams comes from road salt; after correcting for this factor, cation denudation rates are about equal to those at Hubbard Brook. However, silica removal is occurring at a rate more than 30% in the Fort River. When climatic conditions in Hubbard Brook and Fort River are normalized, weathering rates appear consistently higher in the Fort River, reflecting differences in weathering processes (i.e., cation exchange and silicate breakdown) and hydrogeology. Because of uncertainties in mechanisms of cation removal from watersheds, the silica denudation rate may be a better index for weathering intensity. (Author's abstract)
W88-05535

**STUDIES ON SEDIMENTS OF THE RIVER LAHN: 3. TOTAL METAL UPTAKE AND BINDING CONSTANT (UNTERSUCHEN AN LAHNSEDIMENTEN 3. SATTIGUNGSKAPAZITAT UND SORPTIONSKONSTANTE),**
Marburg Univ. (Germany, F.R.). Fachbereich Chemie.
S. Wubbold, W. Spickermann, and G. Stork.
Fresenius' Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 328, No. 8, p 648-652, October 1987, 3 tab, 11 ref.

Descriptors: *Heavy metals, Copper, Lead, Mercury, Cadmium, Iron, Manganese, *Rivers, *Sediments, Langmuir sorption isotherms, Regression Analysis, Correlation Analysis, Heavy metals, Surfactants, Particle size.

To get more detailed information of the different types of bonding for heavy metals to sediments the total metal uptake capacity and the binding constant of 40 sediments of the river Lahn for copper (II) ions were determined from linearized Langmuir sorption isotherms, obtained by batching sediments with copper solutions. These parameters and CHN values complete a data set of analytical results of former investigations (contents of mercury, cadmium, lead, copper, manganese, iron, grain size distribution, etc.). The chemometric treatment of the data set by the partial and multiple correlation analysis, the factor analysis and the multiple regression analysis lead to further details about the intercorrelations between heavy metal bondings and surface active phases of sediments. (Author's abstract)
W88-05561

**TRANSATLANTIC TRANSPORT OF SULFUR,**
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 5B.
W88-05573

**ESTIMATE OF THE IMPORTANCE OF DRY DEPOSITION AS A PATHWAY OF ACIDIC SUBSTANCES FROM THE ATMOSPHERE TO THE BIOSPHERE IN EASTERN CANADA,**
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 5B.
W88-05574

**EQUILIBRIUM APPROACHES TO NATURAL WATER SYSTEMS-6. ACID-BASE PROPERTIES OF A CONCENTRATED BOG-WATER AND ITS COMPLEXATION REACTIONS WITH ALUMINIUM(III),**
Umea Univ. (Sweden). Dept. of Inorganic Chemistry.
L. Lovgren, T. Hedlund, L.-O. Ohman, and S. Sjoberg.
Water Research WATRAG, Vol. 21, No. 11, p 1401-1407, November 1987. 5 fig, 3 tab, 29 ref.

Descriptors: *Acid rain, *Water chemistry, *Chemical properties, *Bogs, *Acidity, *Alkalinity, *Aluminum, *Fate of pollutants, Chemical reactions, Hydrogen ion concentration, Wetlands, Metal complexes, Metals, Equilibrium, Pollutants, Theoretical analysis, Model studies, Solubility, Speciation, Sweden.

A filtered bog-water, obtained from sites in the Svartbergets Forest Research Area in northern Sweden, was concentrated using a freezing technique for studies of its acid-base properties and aluminum(III) complexation reactions. Sampling was performed during autumn and winter periods with a resulting acidity or alkalinity due to oxic (autumn) or anoxic (winter) conditions. The measurements were performed as potentiometric titrations in constant ionic media (0.02, 0.1 and 0.6 M NaCl) with the use of a glass electrode. The samples show buffer ranges at approximately $3 < pH < 5$ and also $pH > 7.5$. The first range is ascribed to the presence of carboxylate groups and is characterized by fast equilibria. The second is due to phenolic OH(-) groups and precipitation reactions with resulting sluggish equilibria. For one sampling period comprehensive measurements were undertaken to determine possible polyelectrolytic character of the organic acids. Due to the small increase in apparent carboxylate pKa values with the degree of dissociation at low (0.02 M) as well as at high (0.6 M) ionic strength, the possible polyelectric feature of the acids was neglected. Instead, a good fit to data was obtained by introducing a diprotic acid (H2L) as a model compound. The expression for the medium dependence of the acidity constants was derived. The complexation with Al(III) was described by the formation of AlL(+), AlL2(-) and the ternary species AlLH sub -1. The stability constants showed no significant trend with sampling period, but indicate a stability of the complexes greater than for phthalic acid but lower than for oxalic acid. The theoretical solubility of the clay mineral kaolinite (Al2(OH)4Si2O5) in the presence of bog-water was modeled by computer. The calculations show that bog-water increases the kaolinite solubility ten-fold at a pH of 5, whereas the effects below pH 4 or above pH about 6.5 are negligible. (Wood-PTT)
W88-05599

**MICROBIAL OXIDATION OF MANGANESE IN A NORTH CAROLINA ESTUARY,**
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
W. G. Sunda, and S. A. Huntsman.
Limnology and Oceanography LIOCAH, Vol. 32, No. 3, p 552-564, May 1987. 8 fig, 2 tab, 35 ref. ONR Contract No. N-00014-80-C-0273.

Descriptors: *Biological oxidation, *Manganese, *North Carolina, *Estuarine environment, *Biotransformation, *Kinetics, *Microbiological studies, Oxidation, Estuaries, Environment, Metabolism, Enzymes, Catalysts, Particulate matter, Heavy metals, Seawater, Chemical reactions, Radioisotopes, Manganese radioisotopes, Isotopic tracers.

Experiments were conducted with Mn54(++) to determine the kinetics of particulate manganese formation in seawater from the lower Newport River estuary, North Carolina. Dissolved Mn was rapidly converted into particles at constant rates that ranged from 0.36 to 6.2%/h, yielding turnover times of the dissolved manganese pool of 0.7-11 d. Dissolved Mn turnover rates increased with temperature up to a maximum at 25-35 C and also increased with the ratio of particulate to dissolved Mn. These two factors explained most of the variation in the observed turnover rates. The formation of particulate Mn appeared to result primarily from the oxidation of Mn(++) to manganese oxides. However, the oxidation rates were much too rapid to be accounted for by abiotic mechanisms, and the rate was reduced by 97% following heat sterilization of the seawater. In addition, the rates conformed to the Michaelis-Menten enzyme kinetics model, providing strong evidence that oxidation of Mn in the estuarine samples is microbially catalyzed. This catalysis appears to be instrumental in the rapid redox cycling of Mn and in the scavenging of dissolved Mn onto particles in aquatic systems. (Author's abstract)
W88-05604

**METHANE IN SURFACE WATERS OF OREGON ESTUARIES AND RIVERS,**
Washington Univ., Seattle. School of Oceanography.
For primary bibliographic entry see Field 2L.
W88-05607

**DETERMINATION OF PHOSPHORUS IN NATURAL WATER USING HYDRIDE GENERATION AND GAS CHROMATOGRAPHY,**
National Research Inst. for Metals, Tokyo (Japan).
S. Hashimoto, K. Fujiwara, and K. Fuwa.
Limnology and Oceanography LIOCAH, Vol. 32, No. 3, p 729-735, May 1987. 4 fig, 2 tab, 13 ref. Ministry of Culture, Science, and Education Grant No. 60030028.

Descriptors: *Chemical analysis, *Water analysis, *Gas chromatography, *Phosphorus, Sample preparation, Reagents, Seawater, Pollutant identification, Phosphates, Ponds, Interference, Arsenic, Silica.

A new hydride-generating method was applied to the determination of phosphorus in seawater and pond water. A sample solution containing phosphate was mixed with a 6% sodium borohydride solution in a quartz vessel and dried under an incandescent light at 40 C for 2 h. Phosphine was reproducibly generated from phosphate by heating this vessel at 460 C. Total phosphorus and total dissolved phosphorus were determined by this method without any digestion procedure, using gas chromatography with a flame photometric detector. Good agreement was found between the hydride-generation method and ordinary colorimetry with sample digestion. The technique eliminates the problems of interference from arsenic, silica, or other materials, has a high sensitivity, and requires only small amounts of sample. Sodium borohydride is the only chemical reagent necessary, reducing the changes of contamination, and, since the system is not complicated, it can be used aboard ship. (Author's abstract)
W88-05608

**CHLORIDE BUDGETS IN TRANSIENT LAKES: LAKES BARINGO, NAIVASHA, AND TURKANA,**
Edinburgh Univ. (Scotland). Dept. of Geophysics.
For primary bibliographic entry see Field 2H.
W88-05610

**IMPORTANCE OF LIQUID WATER CONCENTRATION IN THE ATMOSPHERIC OXIDATION OF SO2,**
Nevada Univ., Reno. Desert Research Inst.
For primary bibliographic entry see Field 5B.
W88-05628

**CUMULUS CLOUD TRANSPORT, SCAVENGING AND CHEMISTRY: OBSERVATIONS AND SIMULATIONS,**
Atmospheric Environment Service, Downsview (Ontario). Cloud Physics Research Div.
A. Tremblay.
Atmospheric Environment ATENBP, Vol. 21, No. 11, p 2345-2364, November, 1987. 8 fig, 7 tab, 19 ref.

Descriptors: *Acid rain, *Clouds, *Cloud physics, *Chemistry, *Precipitation, *Aerosols, Rainfall, Fate of pollutants, Chemistry of precipitation, Model studies, Air pollution, Simulation, Nitrates, Nitric acid, Sulfates, Sulfur dioxide.

Observational and numerical investigations of cumulus cloud scavenging, transport, and chemical processes are presented. The experimental data set includes surface and aircraft measurements of the chemistry and microphysics of aerosol, cloud, and precipitation. Three-dimensional simulations of cloud chemistry and scavenging are performed to help in the interpretation of these experimental data. After adjusting several unmeasured model

parameters, reasonable agreement could be obtained between the simulated and observed cloud chemistry and aerosol distribution in the clouds. The rate at which the simulated clouds transported and transformed pollutants did not exceed a few percent per hour. (Author's abstract)
W88-05629

**CASE STUDIES ON THE CHEMICAL COMPOSITION OF FOGWATER: THE INFLUENCE OF LOCAL GASEOUS EMISSIONS,**
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5B.
W88-05630

**ACIDIC PRECIPITATION IN SOUTHEASTERN ARIZONA: SULFATE, NITRATE AND TRACE-METAL DEPOSITION,**
Princeton Univ., NJ. Center for Energy and Environmental Studies.
C. L. Blanchard, and M. R. Stromberg.
Atmospheric Environment ATENBP, Vol. 21, No. 11, p 2375-2381, November, 1987. 2 fig, 4 tab, 24 ref.

Descriptors: *Arizona, *Acid rain, *Sulfates, *Nitrates, *Trace metals, *Chemistry of precipitation, Hydrogen ion concentration, Waterpollution sources, Rainfall, Metals, Precipitation, Copper, Acidity, Antimony, Arsenic, Cadmium, Lead, Zinc, Heavy metals, Model studies.

Precipitation was collected during 1984 and 1985 at two sites in southeastern Arizona within 100 km of two copper smelters. The precipitation-depth-weighted mean pH was 4.63 and wet sulfate deposition was 8.9 kg/ha over a 13-month period. High acidity and sulfate concentration occurred when upper-level winds were from the directions of the smelters. A smelter 'fingerprint,' based on antimony, arsenic, cadmium, copper, lead, and zinc, was identified, and used to evaluate the smelter contribution to precipitation sulfate on an annually-averaged basis. The variations in the relative proportions of these trace metals were too large to permit application of the method to individual precipitation events. (Author's abstract)
W88-05631

**CHEMICAL COMPOSITION OF ATMOSPHERIC PRECIPITATION IN CZECHOSLOVAKIA, 1976-1984: I. MONTHLY SAMPLES,**
Ustredni Ustav Geologicky, Prague (Czechoslovakia).
For primary bibliographic entry see Field 5B.
W88-05632

**BACTERIAL UTILIZATION OF FORMIC AND ACETIC ACID IN RAINWATER,**
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
L. J. Herlihy, J. N. Galloway, and A. L. Mills.
Atmospheric Environment ATENBP, Vol. 21, No. 11, p 2397-2402, November, 1987. 4 fig, 1 tab, 43 ref.

Descriptors: *Bacterial physiology, *Formic acid, *Acetic acid, *Acid rain, *Chemistry of precipitation, Rainfall, Bacteria, Heterotrophic bacteria, Precipitation, Metabolism, Growth, Microbiological studies, Fate of pollutants, Rain.

Rain samples were collected aseptically during 1983 and 1984 in Charlottesville, VA to determine the ability of bacteria in precipitation to utilize formate and acetate. The total number of bacteria, as counted by Acridine Orange Direct Counts, was one to two orders of magnitude greater from April to September (100,000 cells/ml) than during the rest of the year (1,000-10,000 cells/ml). Formate and acetate concentrations ranged between 6-23 and 3-9 micromolar, respectively, and were higher from June to September. Heterotrophic uptake on the day of collection was not different from the controls, but after incubation at room temperature for a minimum of three days, the turnover rate constants were 0.14 and 0.17/h for formate and acetate, respectively. Total bacterial counts increased an order of magnitude during that interval. These turnover rate constants were used to calculate losses of 44 and 24 micromol/l/day of formic and acetic acid. Turnover times were 1.5 and 34 days for formate and acetate, respectively. This study demonstrated that there are viable microorganisms in the atmosphere capable of utilizing formate and acetate for growth. (Author's abstract)
W88-05633

**CONCENTRATIONS, SPECIATION AND DECOMPOSITION OF ORGANOLEAD COMPOUNDS IN RAINWATER,**
Essex Univ., Colchester (England). Dept. of Chemistry.
M. Radojevic, and R. M. Harrison.
Atmospheric Environment ATENBP, Vol. 21, No. 11, p 2403-2411, November, 1987. 3 fig, 3 tab, 25 ref.

Descriptors: *Lead, *Organic compounds, *Decomposition, *Rain, *Chemistry of precipitation, *Chemical composition, *Chemical reactions, Chromatography, Gas chromatography, Spectroscopy, Atomic absorption spectroscopy, Heavy metals, Inorganic compounds, England, Ireland, Distribution, Seasonal distribution, Path of pollutants.

Tetraalkyllead (R4Pb), trialkyllead (R3Pb(+)), and dialkyllead (R2Pb(++)) compounds were determined in rainwater collected at urban, semi-rural, and rural sites using gas chromatography/atomic absorption spectroscopy (GC/AAS). At sites in England, total organolead concentrations in the range of 10-928 ng Pb/l were found in rainwater and ratios of organic to inorganic lead were between $< 0.1$ and 20%. At a remote rural site on the west coast of Ireland, total organolead concentrations were in the range of 3-13 ng Pb/l. R3Pb(+) species containing mixed alkyl groups were also observed. At a semi-rural site in Southeast England, the deposition rate for total organic lead was 5.6 ng Pb/sq cm/yr. No consistent seasonal variation of alkyllead species or concentration was noted. Stability tests revealed that R4Pb compounds decompose quantitatively within 48 h to R3Pb(+) species in rainwater samples left in the field during sampling programs. R3Pb(+) and R2Pb(++) compounds were found to be very stable in rainwater samples left in the dark. (Author's abstract)
W88-05634

**MECHANISTIC STUDIES OF ANAEROBIC METHANE FORMATION APPLIED TO WASTEWATER TREATMENT FACILITIES,**
Duquesne Univ., Pittsburgh, PA. Dept. of Chemistry.
For primary bibliographic entry see Field 5D.
W88-05647

**GROUND WATER BIOGEOCHEMISTRY OF IRON AND MANGANESE IN RELATION TO WELL WATER QUALITY,**
Helsinki Univ. (Finland). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W88-05740

**STORAGE AND PRESERVATION OF ENVIRONMENTAL SAMPLES,**
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 5A.
W88-05749

**GEOCHEMISTRY OF URANIUM AND THORIUM SERIES NUCLIDES AND OF PLUTONIUM IN THE GULF OF MEXICO: FINAL REPORT,**
Texas A and M Univ., College Station. Dept. of Oceanography.
For primary bibliographic entry see Field 5B.
W88-05750

**EFFECTS OF CONSERVATION TILLAGE PRACTICES ON PESTICIDE VOLATILIZATION AND DEGRADATION,**
Agricultural Research Service, Beltsville, MD.
For primary bibliographic entry see Field 5B.
W88-05768

**EFFECT OF CONSERVATION TILLAGE ON PESTICIDE DISSIPATION,**
Agricultural Research Service, Beltsville, MD.
For primary bibliographic entry see Field 5B.
W88-05769

**SOLUTES,**
Universite Libre de Bruxelles (Belgium). Lab. de Geomorphologie.
For primary bibliographic entry see Field 2C.
W88-05794

**INVESTIGATIONS ON THE INFLUENCE OF ALGAL-DERIVED ORGANIC SUBSTANCES ON FLOCCULATION AND FILTRATION,**
Wahnbachtalsperrenverband, Siegburg (Germany, F.R.).
For primary bibliographic entry see Field 5F.
W88-05821

**SULPHATE, WATER COLOUR AND DISSOLVED ORGANIC CARBON RELATIONSHIPS IN ORGANIC WATERS OF ATLANTIC CANADA,**
Inland Waters Directorate, Ottawa (Ontario). Water Quality Branch.
For primary bibliographic entry see Field 5A.
W88-05867

**SULFATE IN COLOURED WATERS. I. EVALUATION OF CHROMATOGRAPHIC AND COLORIMETRIC DATA COMPATIBILITY,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 5A.
W88-05868

**NATURAL VARIABILITY OF WATER QUALITY IN A TEMPERATE ESTUARY,**
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 2L.
W88-05873

## 2L. Estuaries

**PRODUCTION AND FATE OF METHYLATED SULFUR COMPOUNDS FROM METHIONINE AND DIMETHYLSULFONIOPROPIONATE IN ANOXIC SALT MARSH SEDIMENTS,**
State Univ. of New York at Stony Brook. Marine Sciences Research Center.
R. P. Kiene, and P. T. Visscher.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 10, p 2426-2434, October 1987. 7 fig, 1 tab, 44 ref. NSF Grant OCE-8516604.

Descriptors: *Salt marshes, *Marshes, *Chemical reactions, *Sulfur compounds, *Anaerobic conditions, *Sediments, Metabolism, Methionine, Dimethylsulfoniopropionate, Bacterial degradation, Methane bacteria, Sulfur bacteria, Methanogenesis.

Anoxic salt marsh sediments were amended with DL-methionine and dimethylsulfoniopropionate (DMSP). Microbial metabolism of methionine yielded methane thiol (MSH) as the major volatile organosulfur product, with the formation of lesser amounts of dimethylsulfide (DMS). Biological transformation of DMSP resulted in the rapid release of DMS and only small amounts of MSH. Experiments with microbial inhibitors indicated that production of MSH from methionine was carried out by procaryotic organisms, probably sulfate-reducing bacteria. Methane-producing bacteria did not metabolize methionine. The involvement of specific groups of organisms in DMSP hydrolysis could not be determined with the inhibitors used, because DMSP was hydrolyzed in all samples except those which were autoclaved. Unamended sediment slurries, prepared from Spartina alterniflora sediments, contained significant (1 to

10 microM) concentrations of DMS. Endogenous methylated sulfur compounds and those produced from added methionine and DMSP were consumed by sediment microbes. Both sulfate-reducing and methane-producing bacteria were involved in DMS and MSH consumption. Methanogenesis was stimulated by the volatile organosulfur compounds released from methionine and DMSP. However, apparent competition for these compounds exists between methanogens and sulfate reducers. At low (1 microM) concentrations of methionine, the terminal S-methyl group was metabolized almost exclusively to CO2 and only small amounts of methane. At higher (>100 microM) concentrations of methionine, the proportion of the methyl-sulfur group converted to methane increased. The results of this study demonstrate that methionine and DMSP are potential precursors of methylated sulfur compounds in anoxic sediments and that the microbial community is capable of metabolizing volatile methylated sulfur compounds. (Author's abstract)
W88-05191

**COASTAL-A DISTRIBUTED HYDROLOGIC SIMULATION MODEL FOR LOWER COASTAL PLAIN WATERSHEDS IN GEORGIA,**
Georgia Univ., Athens. Graduate School.
For primary bibliographic entry see Field 2A.
W88-05204

**MONITORING OF MERCURY AND CADMIUM IN COASTAL AREAS, USING AQUATIC ORGANISMS AND SEDIMENT,**
Vandkvalitetsinstitutet, Hoersholm (Denmark).
For primary bibliographic entry see Field 5A.
W88-05261

**HYDROLOGY OF THE REGION BETWEEN THE EASTERN CANARY ISLANDS, MOROCCO AND THE MADEIRA ISLANDS: 'NORCANARIAS I' CAMPAIGN (HIDROLOGIA EN LA REGION COMPRENDIDA ENTRE LAS ISLAS CANARIAS ORIENTALES, MARRUECOS Y LAS ISLAS MADEIRA. CAMPANA 'NORCANARIAS I'),**
Instituto Espanol de Oceanographia, Tenerife (Spain). Centro Costero de Canarias.
R. Molina, and F. L. Laatzen.
Boletin del Instituto Espanol de Oceanografia, Vol. 3, No. 3, p 1-16, December 1986. 20 fig, 6 ref.

Descriptors: *Upwelling, *Water temperature, *Salinity, *Coastal waters, Canary Islands, Temperature gradient, Temperature, Saline water, Distribution patterns, Wind, Ocean circulation.

In the region between the Eastern Canary Islands, Morocco and the Madeira Islands a total of forty-six hydrological stations were carried out during the cruise of the R. V. 'Cornide de Saavedra' in August 1972. Temperature and salinity data obtained at these stations are discussed. The horizontal and vertical distributions of salinity and temperature indicate upwelling off the African coast of waters proceeding from a depth of between 200 and 250 meters which, in accordance with the wind factors, becomes intensified off Cape Ghir and Cape Juby. From a depth of 500 meters, the isolines of both parameters tend to move in an east-west direction. The distribution of density on the surface, maximum stability, and depth of the picnocline also indicate upwelling with an intensification off the same two capes. (Author's abstract)
W88-05286

**STUDY OF THE NITROGEN CYCLE IN SANTANDER BAY (ESTUDIO DEL CICLO DEL NITROGENO EN LA BAHIA DE SANTANDER),**
Instituto Espanol de Oceanografia, Santander (Spain). Centro Costero de Santander.
M. del Olvido Chereguini.
Boletin del Instituto Espanol de Oceanografia, Vol. 3, No. 3, p 23-40, December 1986. 18 fig, 3 tab, 30 ref, append.

Descriptors: *Nitrogen cycle, *Bacteria, *Coastal waters, *Santander Bay, Spain, Aquatic bacteria, Sediments, Proteolytic bacteria, Nitrogen removal, Denitrification, Aerobic bacteria, Hydrogen ion concentration, Salinity, Dissolved oxygen, Nitrates, Nitrogen compounds, Organic carbon, Chemical properties.

Marine bacteria were examined at four stations, two of which were outside, between January 1979 and March 1980 are reported. The bacterial groups studied in the water and in sediments are the ones linked to the nitrogen cycle: proteolytic bacteria, ammonifying bacteria, nitrifying bacteria and denitrifying aerobic bacteria. Some physico-chemical parameters were investigated: pH, salinity, dissolved oxygen, nitrate, nitrite, ammonia, organic carbon (%) and granulometry. In the sediment, there was a significant correlation between the amount of carbon and the proteolytic bacteria. (Wood-PTT)
W88-05287

**BACTERIAL CONTAMINATION OF SANTANDER BAY (CONTAMINACION BACTERIANA EN LA BAHIA DE SANTANDER),**
Instituto Espanol de Oceanografia, Santander (Spain). Centro Costero de Santander.
For primary bibliographic entry see Field 5B.
W88-05288

**SEPARATION OF DINOFLAGELLATE CYSTS INTO DENSITY GRADIENTS (SEPARACION DE QUISTES DE DINOFLAGELADOS EN GRADIENTE DE DENSIDAD),**
Instituto Espanol de Oceanographia, La Coruna (Spain). Centro Costero del La Coruna.
For primary bibliographic entry see Field 7B.
W88-05290

**EFFICIENCY OF LUDOX-TM IN THE SEPARATION OF BENTHIC MICROALGAE FROM SEDIMENT (EFICACIA DEL LUDOX-TM EN LA SEPARACION DE MICROALGAS BENTONICAS DEL SEDIMENTO),**
Instituto Espanol de Oceanographia, La Coruna (Spain). Centro Costero del La Coruna.
For primary bibliographic entry see Field 7B.
W88-05291

**AERIAL SPRAY OF MOSQUITO ADULTICIDES IN A SALT MARSH ENVIRONMENT,**
Harbor Branch Foundation, Inc., Fort Pierce, FL.
For primary bibliographic entry see Field 5B.
W88-05302

**O2 CONSUMPTION AND ACUTE SALINITY EXPOSURE IN THE FRESHWATER SHRIMP MACROBRACHIUM OLFERSII (WIEGMANN) (CRUSTACEA:DECAPODA): WHOLE ANIMAL AND TISSUE RESPIRATION,**
Sao Paulo Univ. (Brazil). Inst. de Ciencias Biomedicas.
J. C. McNamara, and G. S. Moreira.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 113, No. 3, p 221-230, December 15, 1987. 3 tab, 37 ref. Fundacao de Amparo a Pesquisa do Estado de Sao Paulo Grants No. 81/1855-7, 81/1854-0, and 83/0788-0.

Descriptors: *Estuaries, *Bays, *Estuarine environment, *Shrimp, *Aquatic environment, *Salinity, *Respiration, *Oxygen requirements, Crustaceans, Gills, Tissue analysis, Metabolism, Physiological ecology, Animal physiology.

The time course of oxygen consumption after acute salinity exposure was examined in isolated supraesophageal ganglia, gills, and intact Macrobrachium olfersii, a hyperosmoregulating freshwater palaemonid shrimp, to establish patterns of metabolic adjustment during salinity adaptation. In whole shrimp, O2 uptake rates decline with salinity increase to 21 S(practical salinity), increasing with further salinity increase. The rates increase to maxima after 6-12 h exposure to low salinities, decreasing steadily with time in high salinities. In gill preparations, O2 consumption rates increased to a maximum in 14 S, then decline; they are maximal after 3-6 h exposure to low salinities and diminish with time in high salinities. In the supraesophageal ganglion, rates of O2 uptake, measured in seawater of 18 S, are also maximal when shrimp are exposed to 14 S, subsequently declining or leveling off. Rates decrease with time in shrimp exposed to very low salinities, and are stable in 21 S, reaching maxima after 3-6 h exposure of shrimp to all other media. Both tissues thus exhibit characteristic response patterns of O2 consumption rate which appear to depend on their functional significance within the context of the whole organism. Such data are interpreted to indicate an interrelationship between O2 consumption and osmoregulatory capability. (Author's abstract)
W88-05304

**EFFECTS OF BURROWING OF HELICE TRIDENS (DE HAAN) ON THE SOIL OF A SALT-MARSH HABITAT,**
Tohoku Univ., Sendai (Japan). Biological Inst.
S. Takeda, and Y. Kurihara.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 113, No. 1, p 79-89, November 24, 1987. 7 fig, 2 tab, 8 ref.

Descriptors: *Animal behavior, *Salt marshes, *Aquatic habitats, *Crabs, *Soil physical properties, *Soil chemistry, Behavior, Burrowing, Marshes, Habitats, Crustaceans, Soil types, Soil properties, Vertical distribution, Nitrogen, Nutrients, Ammonium, Chemical composition, Organic matter, Decomposition.

The physical and chemical effects of the burrowing activity of the mud crab Helice tridens on the soil of a salt-marsh habitat were investigated. Soil-turnover rate caused by burrowing activity was approximately 3% of the soil from the surface to a depth of 40 cm every day during the summer. The vertical distributions of leaf and stem fragments of the salt-marsh plant Phragmites australis and the vertical distribution of ammonium N concentration in the soil were also investigated. At locations in the marsh where there were many large burrows, numerous leaf and stem fragments were recognized in the soil, while in areas in the marsh containing only a few small burrows, these fragments were scanty. The soil depths at which leaf and stem fragments were abundant corresponded to the depths of the burrows. These results show that mud crabs bury fallen plant fragments in the soil by their burrowing activity. Ammonium N in the soil was also abundant at locations in the marsh where there were many burrows, indicating that organic matter, such as fallen leaves and stems, may be decomposed to inorganic nutrients which are useful to the salt-marsh plants. (Author's abstract)
W88-05307

**PERIODICITY OF EPIPHYTES OF ZOSTERA MARINA IN TWO EMBAYMENTS OF THE SOUTHERN GULF OF ST. LAWRENCE,**
National Research Council, Halifax (Nova Scotia).
I. Novaczek.
Canadian Journal of Botany CJBOAW, Vol. 65, No. 8, p 1676-1681, August 1987. 1 fig, 2 tab, 25 ref.

Descriptors: *Estuaries, *Bays, *Aquatic plants, *Marine plants, *Eelgrass, *Algae, St. Lawrence Gulf, Epiphytes, Photoperiodis, Seasonal variation, Water temperature, Temperature, Plant physiology.

Thirty-eight species of epiphytes (19 red algae, 14 brown algae, and 3 green algae) were identified on growing and cast leaves of Zostera marina (eelgrass) growing in two embayments of the southern Gulf of St. Lawrence. Sampling was done May through December and in February to determine the species composition and temporal pattern of macroalgae. During the sampling period the water temperature ranged from 0 to 24 C; the salinity was generally 24-28 o/oo. Both live and dead leaves of Zostera provided the substratum for algal colonization. Some species occurred sporadically on Zostera while being present on other substrata throughout most or all of the growing season. Other species were discernible for only 1-3 months

of the season. Four epiphytes, Eudesme, Desmotrichum undulatum, Leathesia difformis and Rhodophysema georgii, were studied in culture. The phenological patterns appeared to be regulated by water temperature but not by day length. (Cassar-PTT)
W88-05361

**SEASONAL ABUNDANCE, DISTRIBUTION AND GROWTH OF POSTLARVAL AND JUVENILE GRASS SHRIMP (PALAEMONETES PUGIO) IN A GEORGIA, USA, SALT MARSH,**
Georgia Univ., Sapelo Island. Marine Inst.
R. T. Kneib.
Marine Biology MBIOAJ, Vol. 96, No. 2, p 215-223, October 1987. 5 fig, 3 tab, 30 ref. NSF grant BSR-8300088.

Descriptors: *Estuaries, *Wetlands, *Marshes, *Salt marshes, *Shrimp, *Seasonal variation, *Growth rates, Grass shrimp, Invertebrates, Benthic invertebrates, Sapelo Island, Georgia, Tidal marshes, Tidewater, Aquatic life, Aquatic habitats, Habitats, Juvenile growth stage.

Postlarval and juvenile grass shrimp (Palaemonetes pugio Holthuis) of up to 15 mm total length (TL) were abundant at low tide in shallow aquatic microhabitats (i.e., puddles and films of residual tidal water) in the intertidal zone of a salt marsh on Sapelo Island, Georgia, from 1982 to 1984. The highest concentrations of young P. pugio occurred at 190 to 200 cm above mean low water, about 10-20 cm below mean high water. The intertidal distributions of young grass shrimp expanded and contracted with changes in tidal amplitude. Postlarval grass shrimp (6-8 mm TL) continuously recruited into the intertidal marsh population from May until October, but densities varied in a regular pattern with peaks in abundance occurring at about 2-week intervals, corresponding to spring tide periods in the lunar-tidal cycle. Although present nearly year-round in the intertidal marsh, juveniles (9-15 mm TL) were most abundant from August to October. Apparent growth rates of individuals up to 15 mm TL averaged 0.268 mm/day from May to October and 0.070 mm/day in November and December. Unlike larger aquatic organisms, which can forage in the emergent marsh only when it is flooded by the tide, juvenile grass shrimp have constant access to intertidal resources. Although potentially important predators in this system, the role of young P. pugio in the trophic organization of salt marsh benthic invertebrate assemblages has yet to be examined. (Author's abstract)
W88-05364

**CONTRIBUTION OF C14 DATING TO A BETTER UNDERSTANDING OF THE POM BEHAVIOUR IN ESTUARIES,**
Institut de Geologie du Bassin d'Aquitaine, Talence (France).
J. M. Jouanneau.
Marine Chemistry MRCHBD, Vol. 21, No. 2, p 189-197, July 1987. 5 fig, 3 tab, 23 ref.

Descriptors: *Particulate matter, *Estuaries, *Dating, *Sediments, *Data acquisition, *Carbon-14, *Lead-210, Organic matter, Lead radioisotopes, Carbon radioisotopes, Coasts, Estuarine environment, Cores, Gironde estuary, Tidal flats, Radioisotopes, Sedimentation.

The discordance between radiocarbon dates and dates obtained with Pb210 and historical data in cores recovered from tidal flats of the Gironde estuary (France), is explained. According to the results, it appears that the deposited Particulate Organic Matter (POM), taken into account by C14 dating, is mainly pedologic in origin and relatively old, while other dating techniques provide information on the sedimentation pattern itself. (Author's abstract)
W88-05375

**GEOCHEMICAL ASSOCIATION AND POST-DEPOSITIONAL MOBILITY OF HEAVY METALS IN COASTAL SEDIMENTS: LOCH ETIVE, SCOTLAND,**
Edinburgh Univ. (Scotland). Grant Inst. of Geology.
For primary bibliographic entry see Field 5B.
W88-05376

**EFFECTS OF ACID-IRON WASTES ON ESTUARINE ORGANISMS: RECENT FIELD AND LABORATORY EXPERIMENTS,**
Laboratoire Municipal d'Hygiene, Le Havre (France).
For primary bibliographic entry see Field 5C.
W88-05381

**REGIONAL MANAGEMENT OF DEPLETED AQUIFERS,**
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
For primary bibliographic entry see Field 4B.
W88-05422

**ADAPTATION OF AQUATIC MICROBIAL COMMUNITIES TO HG(++) STRESS,**
Environmental Protection Agency, Gulf Breeze, FL. Gulf Breeze Lab.
For primary bibliographic entry see Field 5C.
W88-05447

**ANNUAL CYCLE OF BACTERIAL SPECIFIC BIOVOLUMES IN HOWE SOUND, A CANADIAN WEST COAST FJORD SOUND,**
Simon Fraser Univ., Burnaby (British Columbia). Dept. of Biological Sciences.
L. J. Albright, and S. K. McCrae.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 12, p 2739-2744, December 1987. 6 fig, 40 ref.

Descriptors: *Estuaries, *Fjords, *Bacteria, *Seasonal variation, *Biovolume, Howe Sound, British Columbia, Plankton, Chlorophyll, Aquatic bacteria, Chlorophyta, Dinoflagellates, Phytoplankton, Algae, Water temperature, Temperature.

The mean specific biovolumes (biovolume/cell) of the bacterioplankton within a 250-m-deep water column in Howe Sound, British Columbia, were determined for the period of 4 September 1984 to 23 October 1985. These bacteria had an annual cycle in mean specific biovolume; they were small (ca. 0.058 cu micron) in mid-winter, larger in spring (ca. 0.076 cu micron), larger again in summer (up to 0.102 cu micron), and largest (ca. 0.133 cu micron) in early fall, immediately after the decrease in phytoplankton production. The mean specific biovolumes changed coincidently through the water column with time, although the larger bacterioplankton tended to occur in the surface and deepest water. Although the mean specific biovolumes correlated better with in situ temperature than with in situ chlorophyll a concentration, modeling experiments with batch cultures of the dinoflagellate Prorocentrum minimum (Pavillard) and the green alga Dunaliella tertiolecta (Butcher) indicated that the biomass and physiological condition of the phytoplankters may be more important than temperature in determining these bacterial specific biovolumes. (Author's abstract)
W88-05448

**LOCAL CHANGES OF SALINITY AND NUTRIENTS AND PROCESSES CONTRIBUTING TO THE NUTRIENT DISTRIBUTION OFF THE EVROS RIVER, IN THE NORTH AEGEAN SEA,**
Institute of Oceanographic and Fisheries Research, Athens (Greece).
For primary bibliographic entry see Field 5B.
W88-05495

**TURBIDITY CURRENT ACTIVITY IN A BRITISH COLUMBIA FJORD,**
Louisiana State Univ., Baton Rouge.
D. B. Prior, B. D. Bornhold, W. J. Wiseman, and D. R. Lowe.
Science SCIEAS, Vol. 237, No. 4820, p 1330-1333, September 11, 1987. 4 fig, 12 ref. NSF Grant DPP-8501118.

Descriptors: *Turbidity currents, *Fjords, *Sediment transport, *Sand, *Bottom currents, *Monitoring, Sediment load, Sediment carrying capacity, Channel flow, Water currents, Turbidity, Bottom water, Bottom sediments, Turbidity flow, Velocity, British Columbia, Canada, Slopes.

A year-long monitoring program within an elongated channel-fan system in Bute Inlet of British Columbia, Canada, detected active sand-transporting turbidity currents. Measurements of bottom velocities and sediment collected in traps, as well as damage to moorings and equipment, captured the signatures of frequent energetic events. Maximum calculated velocities achieved 335 centimeters per second, with flow thickness of more than 30 meters. Coarse sand was transported as least 6 to 7.5 meters above the sea floor. Turbidity currents flowed a minimum distance of 25.9 kilometers, but possibly as far as 40 to 50 kilometers over bottom slopes of generally less than 1 degree. (Author's abstract)
W88-05504

**EFFECTS OF THE BRACKISH DEPOSIT-FEEDING POLYCHAETES NOTOMASTUS SP. (CAPITELLIDAE) AND NEANTHES JAPONICA (IZUKA) (NEREIDAE) ON SEDIMENTARY O2 CONSUMPTION AND CO2 PRODUCTION RATES,**
Tohoku Univ., Sendai (Japan). Biological Inst.
E. Kikuchi.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 114, No. 1, p 15-25, December 22, 1987. 5 fig, 3 tab, 27 ref. Min. Educ., Cult., Sci. (Japan) Grant No. 62602502.

Descriptors: *Polychaetes, *Brackish water, *Oxygen requirements, *Carbon dioxide, *Benthic fauna, *Sediment-water interfaces, Annelids, Biomass, Environment, Benthic environment, Marine environment, Aquatic animals, Benthos, Fauna, Respiration, Interfaces, Sediments, Bottom sediments.

The benthic O2 consumption and CO2 production of sieved sediment cores containing a varied biomass of two polychaete species, Notomastus sp. (deep deposit-feeder) and Neanthes japonica (surface deposit-feeder), were measured simultaneously. Each species increased the benthic O2 consumption and CO2 production in proportion to its biomass. This increase was not explained by the respiration of the animals alone. The residual O2 and CO2 fluxes increased markedly in the presence of polychaetes. In the presence of Notomastus (the deeper burrowing species with low irrigation activity), the enhanced CO2 flux was much higher than that in the presence of Neanthes, whereas the enhanced O2 flux was lower in the presence of Notomastus. (Author's abstract)
W88-05513

**HEPATITIS A VIRUS AND POLIOVIRUS 1 INACTIVATION IN ESTUARINE WATER,**
For primary bibliographic entry see Field 5B.
W88-05589

**INCIDENCE OF YEASTS IN COASTAL SEA WATER OF THE ATTICA PENINSULA, GREECE,**
Athens School of Hygiene (Greece).
A. Velegraki-Abel, U. Marselou-Kinti, and C. Richardson.
Water Research WATRAG, Vol. 21, No. 11, p 1363-1369, November 1987. 4 fig, 3 tab, 23 ref.

Descriptors: *Yeasts, *Coastal waters, *Pollutant identification, Pollutants, Attica Peninsula, Greece, Fungi, Distribution patterns, Seasonal variation, Pathogenic fungi.

Coastal sea water from 15 locations around the Attica peninsula, Greece, was collected and analyzed for the presence of yeasts on three occasions during 1984. Yeast cell densities ranged from 30 to 1020 colony-forming units (CFU)/50 ml. There was a marked increase in yeast cell densities during the summer months. A total of 30 yeast species

were recorded, single sampling stations yielding from 8 to 27 species. Qualitative differences between sites were consistent throughout the sampling period. Potentially pathogenic species, often in high numbers, were recorded from many stations, the most common being Rhodotorula spp, Candida spp, and Torulopsis glabrata. Among isolates of Candida albicans, serotype B occurred significantly more frequently than serotype A. (Author's abstract)
W88-05593

**MICROBIAL OXIDATION OF MANGANESE IN A NORTH CAROLINA ESTUARY,**
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
For primary bibliographic entry see Field 2K.
W88-05604

**METHANE IN SURFACE WATERS OF OREGON ESTUARIES AND RIVERS,**
Washington Univ., Seattle. School of Oceanography.
M. A. de Angelis, and M. D. Lilley.
Limnology and Oceanography LIOCAH, Vol. 32, No. 3, p 716-722, May 1987. 4 fig, 3 tab, 24 ref. NSF Grant No. OCE 79-27283 and ONR Grant No. N00014-79-C-0004.

Descriptors: *Methane, *Oregon, *Estuaries, *Rivers, *Chemical properties, Mixing, Runoff, Diffusion, Soil types, Saturated soils, Forest soils, Agricultural runoff, Seawater.

Methane concentrations in surface waters of Oregon rivers and estuaries were measured over a four-year period. Geographic variations in riverine CH4 were observed. Results from undisturbed forest streams indicate that rivers can contain high natural levels of CH4 not attributable to pollution. Lateral diffusion and runoff from saturated forest and fertilized agricultural soils may be important in determining methane levels in rivers. Methane concentrations in well-flushed estuaries appear to be controlled mainly by mixing between high CH4-containing river water and low CH4-containing seawater endmembers. Rivers and estuaries were found to be sources of methane to the atmosphere. Calculated daily fluxes to the atmosphere ranged from 1.2 to 71 mg CH4/sq m for rivers and from 0.04 to 21 mg CH4/sq m for estuarine samples. (Author's abstract)
W88-05607

**SHORT-TERM ENVIRONMENTAL VARIABILITY AND PHYTOPLANKTON ABUNDANCE IN A SHALLOW TIDAL ESTUARY: I. WINTER AND SUMMER,**
Duke Univ., Beaufort, NC. Marine Lab.
W. Litaker, C. S. Duke, B. E. Kenney, and J. Ramus.
Marine Biology MBIOAJ, Vol. 96, No. 1, p 115-121, October, 1987. 3 fig, 1 tab, 26 ref. NSF Grant No. OCE-81-13328.

Descriptors: *Population density, *Phytoplankton, *Estuarine environment, *Seasonal distribution, *Marine biology, *Physiological ecology, Density, Environment, Estuaries, Distribution, Sampling, Nutrients, Ecology, Nitrates, Ammonium, Runoff, Chlorophyll a, Biomass, Grazing, Aquatic plants, Plankton, Chemical properties, Physical properties, Biological properties, Monitoring, Newport River, North Carolina.

Fixed-point sampling of a shallow tidal estuary (the Newport River Estuary, NC) was performed hourly for 14 d in summer of 1982 and again in winter of 1983 to allow characterization of the variability between periods of 2 to 96 h by spectral analysis of the time-series. Twenty-eight parameters were monitored, encompassing meteorology, hydrology, water chemistry, and phytoplankton-production physiology. Although the annual cycle was monitored, only the winter and summer seasons were compared here, i.e., the lowest water temperatures with the highest water temperatures. The physics, chemistry, and biology of the estuary at the hourly scale were highly variable and non-random. The estuary is riverine in winter; growth-limiting nitrogen is supplied as nitrate and ammonium by runoff from the drainage basin. In summer, the estuary is lagoonal; nitrogen is supplied as NH4(+) by biological regeneration. Chlorophyll a biomass varies primarily at the 4 d period in winter and at the diel period in summer. Although finely tuned to environmental variability, phytoplankton abundances were at equilibrium insofar as daily chlorophyll production was balanced by losses, i.e., grazing, export, and deposition. Most important, high-frequency processes (periods at the scale of cell-division times) can be very important in phytoplankton ecology. (Author's abstract)
W88-05644

**DIEL VARIATION IN THE ABUNDANCE OF EPIFAUNA ASSOCIATED WITH SEAGRASSES OF THE INDIAN RIVER, FLORIDA, U.S.A.,**
Harbor Branch Inst., Inc., Fort Pierce, FL.
R. K. Howard.
Marine Biology MBIOAJ, Vol. 96, No. 1, p 137-142, October, 1987. 4 fig, 2 tab, 33 ref.

Descriptors: *Diurnal distribution, *Population density, *Aquatic animals, *Sea grasses, *Indian River, *Epifauna, *Lagoons, Florida, Density, Distribution, Aquatic plants, Gastropods, Crustaceans, Mollusks, Leaves, Benthic fauna, Benthos, Fauna, Ecology.

Day-night comparisons of the motile epifauna in the canopy of seagrass beds in the Indian River lagoon, FL revealed that abundances were not stable over the diel period. Collections were made between February and June, 1982. Higher densities of epifauna occurred on seagrasses at night. For both of the numerically-dominant gastropod and crustacean groups, four of the five top-ranked species followed this diel pattern. Crustaceans showed particularly large changes in abundance, averaging a twofold increase in nocturnal samples. Faunal similarity between day and night collections remained high, however, indicating that community structure was preserved during diel abundance changes. It is concluded that equating epifauna collected from seagrass blades with those associated with the seagrass habitat in general may be erroneous, particularly if collections are made during daylight. Changes in prey availability due to the diel pattern are likely to extend to important community trophic functions. (Author's abstract)
W88-05645

**FIELD STUDY OF THE TOXICITY OF TWO OILS AND A DISPERSANT TO THE MANGROVE AVICENNIA MARINA,**
Adelaide Univ. (Australia). Centre of Environmental Studies.
For primary bibliographic entry see Field 5C.
W88-05646

**SEASONAL CHANGES IN THE TRACE METALS IN SALT MARSH ANGIOSPERMS,**
Bielefeld Univ. (Germany, F.R.). Fakultaet fuer Biologie.
A. J. Joshi, M. Engenhart, M. Wickern, and S. W. Breckle.
Journal of Plant Physiology JPPHEY, Vol. 128, No. 1-2, p 173-177, May, 1987. 3 tab, 15 ref.

Descriptors: *Seasonal distribution, *Trace metals, *Salt marshes, *Marsh plants, *Plant physiology, *Nutrients, Distribution, Metals, Heavy metals, Marshes, Aquatic plants, Iron, Manganese, Copper, Nickel, Lead, Minerals, Roots, Leaves, Translocation, Halophytes, Zinc.

Variations in Fe(+++), Mn(++), Cu(++), Ni(++), and Pb(++) content were studied in five salt marsh species in India. Maximum accumulation of Fe(+++) and Mn(++) was observed in Atriplex griffithii and Salicornia brachiata; while Cu(++) was more in Juncus maritimus. Concentration of Ni(++) and Pb(++) reached up to 12 and 7 mg/kg, respectively, in A. griffithii. Increase in Fe(+++), Mn(++), Zn(++), and Ni(++) was noticed in succulent halophytes during the winter. Progressive translocation of the first two metals from roots to leaves was observed in A. griffithii. (Author's abstract)
W88-05653

**PROTECTING FRESHWATER INFLOWS INTO TEXAS ESTUARIES: AN EVALUATION OF LEGAL STRATEGIES,**
Texas A and M Univ., College Station. Inst. of Renewable Natural Resources.
For primary bibliographic entry see Field 6E.
W88-05667

**OUR NATIONAL WETLAND HERITAGE: A PROTECTION GUIDEBOOK,**
For primary bibliographic entry see Field 6E.
W88-05703

**CORPUS CHRISTI INNER HARBOR SHOALING INVESTIGATION,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
T. M. Smith, W. H. McAnally, and A. M. Teeter.
Available from the National Technical Information Service, Springfield, VA 22161. Technical Report No. HL-87-13, September 1987. Final Report. 208 p, 19 fig, 2 tab, 20 ref, 3 append.

Descriptors: *Sedimentation, *Corpus Christi, *Texas, *Shoals, *Density currents, *Model studies, Harbors, Sediment load, Water currents, TABS-2, LAEMSED, Mathematical models, Hydraulic models.

A combination of numerical models was used to test alternatives for shoaling prevention in Corpus Christi Harbor, Texas. The vertically averaged model system, TABS-2, was used to simulate contributions of sediments by bay waters to the sediment load. The laterally averaged estuarine model, LAEMSED, was used to simulate density currents in the channel and sedimentation that occurs at the harbor entrance. Applications of the models testing advance maintenance, removal of industrial discharges and withdrawals, advance maintenance in conjunction with a sill, and movement of the disposal areas showed a 20% decrease in shoaling as a result of industrial activity removal, a 75% decrease in sediments entering the bay channel due to disposal area relocation, and practically no effect on shoaling rates resulting from advance maintenance. Appendices present: the results of a reconnaissance survey on shoaling conditions in Corpus Christi Harbor; the TABS-2 numerical modeling system; and the theoretical aspects of LAEMSED. (Author's abstract)
W88-05713

**GEOCHEMISTRY OF URANIUM AND THORIUM SERIES NUCLIDES AND OF PLUTONIUM IN THE GULF OF MEXICO: FINAL REPORT,**
Texas A and M Univ., College Station. Dept. of Oceanography.
For primary bibliographic entry see Field 5B.
W88-05750

**EMERSION IN THE MANGROVE FOREST FISH RIVULUS MARMORATUS: A UNIQUE RESPONSE TO HYDROGEN SULFIDE,**
Charleston Coll., SC.
D. C. Abel, C. C. Koenig, and W. P. Davis.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-212932. Price codes: A02 in paper copy, A01 in microfiche. EPA Report No. EPA/600/J-87/061, 1987. 72 p, 1 fig, 2 tab, 16 ref.

Descriptors: *Mangrove swamps, *Rivulus marmoratus, *Environmental effects, *Hydrogen sulfide, *Oxygen consumption, Predation, Water pollution effects, Water level, Toxicity, Oxygen, Stress.

The mangrove forest fish Rivulus marmoratus (Cyprinodontidae) has frequently been observed out of water, a phenomenon generally attributed to habitat drying. The hypothesis that hydrogen sulfide, a substance characteristically found in their environment, can serve as a stimulus for emersion, is tested

in this study. In the field R. marmoratus was found in water with low to moderate levels (<250 ppb) of H2S. In the laboratory, R. marmora leaped from water contaminated with H2S at ecologically relevant concentrations (median response at 123 ppb). Aquatic hypoxia did not induce emersion, but prey capture did. Oxygen consumption by both juveniles and adults decreased significantly in air (27 and 25%, respectively). These results suggest that avoidance of H2S and the ability to survive terrestrial conditions enable this species to permanently occupy an area of the forest unavailable to other fishes. Furthermore, because a variety of stimuli lead to emersion in R. marmoratus, terrestriality in this species is likely a generalized response to environmental stress as well as a means of exploiting terrestrial resources. (Author's abstract)
W88-05856

**EFFECTS OF BLACK ROCK HARBOR DREDGED MATERIAL ON THE SCOPE FOR GROWTH OF THE BLUE MUSSEL, MYTILUS EDULIS, AFTER LABORATORY AND FIELD EXPOSURES,**
Environmental Research Lab., Narragansett, RI.
For primary bibliographic entry see Field 5C.
W88-05860

**NATURAL VARIABILITY OF WATER QUALITY IN A TEMPERATE ESTUARY,**
Virginia Inst. of Marine Science, Gloucester Point.
L. E. Gadbois, and B. J. Neilson.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 158-171, 4 fig, 1 tab, 9 ref.

Descriptors: *Statistics, *Water quality, *Estuaries, Natural variation, Monitoring, Data interpretation, Tides, Nitrogen, Phosphorus, Seasonal variation.

Interpreting the data from water quality monitoring networks is difficult if the natural variability of the system is not known. Analysis of data from estuaries is made more difficult by the advection of spatial patterns with the oscillating tides. Samples were collected from a polyhaline, partially-mixed estuary which typically has minimal longitudinal gradients for most water quality measures. Water samples from a 2.5 meter shoal were analyzed for nitrogen and phosphorus content. Data from two 57-hr intensive studies indicate that hourly fluctuations were on the order of 15%. The variations showed no significant correlation with tidal height. Other samples collected at 45 min intervals were composited to determine daily average conditions over an annual cycle. In addition to a strong seasonal signal, daily fluctuations were on the order of 20 - 50% for total nitrogen and total phosphorus and 30 - 70% for nitrate-plus-nitrite nitrogen. Data from monitoring networks with less frequent observations must be interpreted with caution given the magnitude of these short term variations which are assumed to arise from natural phenomena. (See also W88-05862) (Author's abstract)
W88-05873

# 3. WATER SUPPLY AUGMENTATION AND CONSERVATION

## 3B. Water Yield Improvement

**USE OF STREAMFLOW INCREASES FROM VEGETATION MANAGEMENT IN THE VERDE RIVER BASIN,**
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
T. C. Brown, and M. M. Fogel.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1149-1160, December 1987. 2 fig, 4 tab, 24 ref.

Descriptors: *Water yield improvement, *Streamflow, *Vegetation effects, *Vegetation management, *Model studies, Water use, Water yield, Streamflow augmentation, Streams, Verde River Basin, Arizona, Mathematical equations, Mathematical studies, Simulation, Surface water, Water storage, River basins.

Although the effects of vegetation management on streamflow have been studied in many locations, the effects of augmented streamflow on downstream water users have not been carefully analyzed. The routing of streamflow increases that could be produced in the Verde River Basin of Arizona was examined. Reservoir management and water routing to users in the Salt River Valley around Phoenix were carefully modeled. Simulation of water routing with and without vegetation modification indicates that, under current institutional conditions, less than one-half of the streamflow increase would reach consumptive users as surface water. Most of the remainder would accumulate in storage until a year of unusually heavy runoff, when it would add to reservoir spills. Under alternative scenarios, from 39 to 58 percent of the streamflow increase was delivered to consumptive users. (Author's abstract)
W88-05419

**PROJECTING STORAGE IN HIGHLAND LAKE RESERVOIR SYSTEM,**
HDR Infrastructure, Inc., Austin, TX.
S. K. Vaugh, and D. R. Maidment.
Journal of Water Planning Resources and Management (ASCE) JWRMD5, Vol. 113, No. 5, p 659-676, September, 1987. 9 fig, 1 tab, 14 ref, 1 append.

Descriptors: *Water yield, *Reservoir operation, *Probability distribution, *Highland Lake System, *Projections, *Simulation, *Water management, Storage, Reservoirs, Storage reservoirs, Water supply, Water demand, Flow, Mathematical analysis, Evaporation, Reservoir evaporation.

The probability distribution of storage in the Highland Lakes reservoir system on the Lower Colorado River in Central Texas is projected up to six years into the future. Projections are based on simulation using historical hydrologic data, initial storage conditions, expected water demands, and system operation policy. Results are compared with those obtained by application of Gould's probability matrix method, which assumes annually uncorrelated hydrologic data. Although serial correlation of combined annual inflows is not statistically significant, it is demonstrated that persistence in the annual data reduces the expected system storage under steady-state conditions from 86.5% to 81.7% of the active storage capacity. Mechanisms are illustrated for evaluating the effect of reductions in contracted water supply on future reservoir storage levels. (Author's abstract)
W88-05640

**HIERARCHICAL ALGORITHM FOR WATER SUPPLY EXPANSION,**
Lower Colorado River Authority, Austin, TX. Water Policy and Programs Div.
For primary bibliographic entry see Field 6A.
W88-05641

**ADAPTING SURFACE WATER LAW TO ATMOSPHERIC WATER RESOURCES TECHNOLOGY,**
Brigham Young Univ., Provo, UT. J. Reuben Clark Law School.
For primary bibliographic entry see Field 6E.
W88-05675

**CLOUD PHYSICS STUDIES IN SCPP FROM 1977-87,**
Wyoming Univ., Laramie. Dept. of Atmospheric Science.
J. D. Marwitz.
Available from the National Technical Information Service, Springfield, VA. 22161. Report No. AS 157, October 1987. 108 p, 35 fig, 1 tab, 51 ref, append. DOI Contract No. 2-07-81-V0256.

Descriptors: *Cloud physics, *Weather modification, *Sierra Cooperative Pilot Project, Precipitation, Orographic precipitation, Sierra Nevada Mountains, Ice.

This final report is a summary of the cloud physics studies by University of Wyoming investigators as participants in the Sierra Cooperative Pilot Project (SCPP) from 1977 to 1987. The dynamic and precipitation processes are discussed in: deep, stable orographic clouds; deep, unstable orographic clouds; shallow, stable orographic clouds; shallow unstable orographic clouds; unstable rainbands; and stable rainbands. The barrier jet and the Hallett-Mossop secondary ice crystal processes are both found to be ubiquitous in Sierra storms. (Author's abstract)
W88-05705

## 3C. Use Of Water Of Impaired Quality

**SALINITY MANAGEMENT MODEL: I. DEVELOPMENT,**
Ain Shams Univ., Cairo (Egypt). Dept. of Irrigation and Hydrology.
For primary bibliographic entry see Field 5B.
W88-05134

**SALINITY MANAGEMENT MODEL: II. 1- AND 2-D APPLICATIONS,**
Ain Shams Univ., Cairo (Egypt). Dept. of Irrigation and Hydrology.
For primary bibliographic entry see Field 5B.
W88-05135

**QUALITY REQUIREMENTS FOR IRRIGATION WITH SEWAGE WATER,**
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
H. Bouwer, and E. Idelovitch.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 516-535, November 1987. 9 tab, 23 ref.

Descriptors: *Wastewater irrigation, *Impaired water use, *Wastewater, *Effluents, *Food crops, Agriculture, Water quality, Irrigation, Nutrients, Public health, Salinity, Pathogens.

Irrigation is an excellent use for sewage effluent because it is mostly water with nutrients. For small flows, the effluent can be used on special, well-supervised 'sewage farms,' where forage, fiber, or seed crops are grown that can be irrigated with standard primary or secondary effluent. Large-scale use of the effluent requires special treatment so that it meets the public health, agronomic, and aesthetic requirements for unrestricted use (no adverse effects on crops, soils, humans, and animals). Crops in the unrestricted-use category include those that are consumed raw or brought raw into the kitchen. Most state or government standards deal only with public health aspects, and prescribe the treatment processes or the quality parameters that the effluent must meet before it can be used to irrigate a certain category of crops. However, agronomic aspects related to crops and soils must also be taken into account. Quality parameters to be considered include bacteria, viruses, and other pathogens; total salt content and sodium adsorption ratio of the water (soil as well as crop effects); nitrogen; phosphorus; chloride and chlorine; bicarbonate; heavy metals, boron, and other trace elements; pH; and synthetic organics (including pesticides). (Author's abstract)
W88-05139

**USE OF RECLAIMED WASTEWATER FOR CONCRETE MIXING,**
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
For primary bibliographic entry see Field 8F.
W88-05173

**NEW CONCEPT IN CLARIFIERS,**
Smally, Wellford and Nalven, Inc., Sarasota, FL.
For primary bibliographic entry see Field 5D.
W88-05343

**IMPACT OF POTASSIUM, SODIUM, AND SALINITY ON THE PROTEIN-AND FREE AMINO ACID CONTENT OF WHEAT GRAIN,**
Nevada Univ., Reno. Dept. of Plant Science.
D. A. Devitt, L. H. Stolzy, and C. K. Labanauskas.
Plant and Soil PLSOA2, Vol. 103, No. 1, p 101-109, 1987. 2 fig, 7 tab, 15 ref.

Descriptors: *Irrigation effects, *Potassium, *Sodium, *Salinity, *Wheat, *Amino acids, *Proteins, Plant Physiology, Saline water, Lysimeters, Soil water, Grain crops.

A lysimeter study was conducted on Cajeme wheat (Triticum aestivum L.) to investigate the impact of salinity on protein and free amino acid content of the grain. Cross correlations were obtained between 16 different soil-plant-water based parameters and the concentration and total accumulation of amino acids. The results indicated that after 3 years of irrigation, the majority of protein bound and free amino acids increased in concentration in the grain. However, both free tryptophan and free proline revealed decreasing concentrations with increasing salinity. Free tryptophan showed a synergism between total accumulation, yield and concentration. Free proline concentrations decreased in association with increasing protein concentrations. Cross correlations of the 16 soil-plant-water based parameters with free and protein bound amino acids revealed significant correlations for free aspartic acid and glycine with total accumulation but not with concentrations. Only methionine plus cystine was lower than suggested FAO levels for essential amino acids and was lower in the third year than in the first year. (Author's abstract)
W88-05570

**PHYSICAL AND COMPUTER MODELS OF MULTIQUALITY NETWORKS,**
Technion - Israel Inst. of Tech., Haifa. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5F.
W88-05612

## 3D. Conservation In Domestic and Municipal Use

**INTEGRATING DEMAND MANAGEMENT OF URBAN REGIONAL WATER SYSTEMS: A CANADIAN CASE STUDY AND IMPLICATIONS,**
Michigan Univ., Ann Arbor.
For primary bibliographic entry see Field 6D.
W88-05206

**METROPOLITAN WATER SUPPLY SYSTEM OPTIMIZATION FOR WATER ALLOCATION DURING DROUGHT IN SALT LAKE COUNTY,**
Utah State Univ., Logan. Coll. of Engineering.
For primary bibliographic entry see Field 6D.
W88-05219

**REPLACEMENT RULES FOR WATER MAINS,**
Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5F.
W88-05323

**INTERVENTION ANALYSIS OF WATER USE RESTRICTION, AUSTIN, TEXAS,**
Texas Univ. at Austin. Dept. of Civil Engineering.
D. T. Shaw, and D. R. Maidment.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1037-1046, December 1987. 5 fig, 3 tab, 20 ref. Texas Water Resources Institute Agreement UT-86-2.

Descriptors: *Water conservation, *Intervention analysis, *Water use restriction, *Municipal water, Water use, Model studies, Mathematical equations, Mathematical studies, Austin, Texas, Lawns.

Mandatory water conservation in the form of restrictions on outdoor watering, car washing, and recreation was implemented in the City of Austin, Texas, during the summers of 1984 and 1985. Three different stages of restrictions were implemented limiting the number of watering hours per day, as well as a restriction that allowed lawn watering once every five days according to the last digit of the street address. Intervention analysis using a transfer function-noise model of daily water use is applied to assess the impact of the restrictions. Compared to a peak water use rate of about 170 MGD, it is shown that mandatory restrictions in 1984 reduced water use by an average of 13.5 MGD, while similar restrictions during the summer of 1985 reduced usage by an average of 5.5 MGD. Lawn watering restrictions on a five-day cycle produced a corresponding five-day cycle in water use of more than 10 MGD in amplitude in 1985. An alternative lawn watering scheme that eliminates this cycle is prescribed. (Author's abstract)
W88-05405

**FEASIBILITY OF SEASONAL WATER PRICING CONSIDERING METERING COSTS,**
Nevada Univ., Reno. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6C.
W88-05412

**MODEL OF DAILY MUNICIPAL WATER USE FOR SHORT-TERM FORECASTING,**
Interstate Commission on the Potomac River Basin, Rockville, MD.
For primary bibliographic entry see Field 6D.
W88-05434

**EVALUATION AND SCHEDULING OF WATER CONSERVATION,**
California Univ., Davis. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6B.
W88-05642

**SURFACE WATER FEES USED TO REDUCE URBAN FLOODING,**
King County Dept. of Public Works, Seattle, WA.
For primary bibliographic entry see Field 6F.
W88-05650

## 3F. Conservation In Agriculture

**CLASSIFICATION OF IRRIGATION WATER CONVEYANCE SYSTEM COMPONENTS,**
Calgary Univ. (Alberta). Dept. of Civil Engineering.
D. H. Manz.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 479-496, November 1987. 10 tab, 13 ref, 3 append.

Descriptors: *Irrigation systems, *Pipelines, *Water storage, *Water transfer, *Depth control, *Diversion, Irrigation, Mathematical equations, Hydraulics.

Classification systems for irrigation water conveyance facility components which directly affect the operation of open channel and pipeline systems are presented. Components are initially classified into four groups depending on the water management function they are intended to satisfy: diversion; depth-control, transfer; and storage. These groups are further classified into thirty-two types of diversion structures, thirty-two types of depth-control structures, four types of transfer structures, and three types of storage facilities. General equations describing the hydraulics and operation of diversion, depth-control, and water transfer structures are also provided. Multiple outlet and compound and multifunction structures are also addressed. (Author's abstract)
W88-05137

**MODELING SURGE IRRIGATION INFILTRATION,**
Texas Univ. at Austin. Center for Research in Water Resources.
A. W. Blair, and E. T. Smerdon.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 497-515, November 1987. 9 fig, 6 tab, 16 ref. Water Resources Research Program Grant 14-08-001-G1129.

Descriptors: *Surge irrigation, *Model studies, *Infiltration, *Furrow irrigation, *Irrigation management, Mathematical equations, Irrigation, Prediction, Infiltrometers, Mathematical models.

A recirculating furrow infiltrometer is used to measure infiltration for simulated surge irrigation for various cycle times and cycle ratios. The data collected from three locations is used to evaluate two empirical surge infiltration models, one of which was developed by the authors. The effects of furrow geometry, surface depression storage, recession and advance time, and measurement error are considered. The evaluations indicate that a model based on the Kostiakov equation, the surge cycle ratio, and the surge cycle time works well in predicting infiltration during surge. This model, which considers surge cycle ratio and cycle time, is both simple and useful in surge irrigation design. Most importantly, it allows surge infiltration to be determined directly, without surge infiltration data, from continuous infiltration data. (Author's abstract)
W88-05138

**FURROW MODEL WITH SPECIFIED SPACE INTERVALS,**
California Univ., Davis. Dept. of Land, Air and Water Resources.
M. Rayej, and W. W. Wallender.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 536-548, November 1987. 8 fig, 1 tab, 15 ref.

Descriptors: *Model studies, *Infiltration, *Furrow irrigation, *Irrigation management, Mathematical equations, Irrigation, Prediction, Soil properties, Field tests, Mathematical models.

A complete furrow irrigation model was developed based on the cumulative solution of the volume balance equation, rather than the incremental solution. Space intervals were given (constant or variable) to allow infiltration characteristics to vary along the length of the furrow. The cumulative model predicted more accurately than the incremental model when compared to field data and the kinematic wave model results. Further, the incremental solution due to larger numerical error and over-simplification of post-advance phases. This deviation was larger for high-intake soils. Field slope and roughness, however, did not influence the difference in accuracy between the two models as much as soil intake. (Author's abstract)
W88-05140

**PLANNING MODEL OF IRRIGATION DISTRICT,**
Universidad Autonomia Chapingo (Mexico). Colegio de Postgraduados.
J. Chavez-Morales, M. A. Marino, and E. A. Holzapfel.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 549-564, November 1987. 2 fig, 4 tab, 16 ref. Agricultural Research Service Cooperative Agreement 4350-H.

Descriptors: *Model studies, *Irrigation management, *Mexico, *Food crops, *Economic aspects, *Crop yield, *Cost analysis, *Prices, Irrigation, Reservoirs, Aquifers, Groundwater, Agriculture, Prediction.

A linear optimization model for planning the management of Irrigation District No. 38, in the State of Sonora, Mexico, is presented. The model considers the yield, price, and production cost of twelve primary crops; the land restriction on cropped areas; the storage capacity of the existing reservoir and aquifer; the reservoir net inflows; the evaporation, releases, and spillages from the reservoir; the surface water and groundwater requirements of the crops; the quality of the mix of

surface water and groundwater; and the requirements of other resources, such as fertilizer, pesticide, seed, equipment, and labor. The model gives the cropping pattern and the monthly schedule of reservoir releases and aquifer withdrawals that maximize the annual profit in the district. Solutions to the model facilitate an evaluation of the effects of net annual inflows on profits and cropped areas, and provide an indication of the levels of inflow that can be used for planning the operation of the irrigation district. (Author's abstract)
W88-05141

**EVAPOTRANSPIRATION ESTIMATES IN EXTREMELY ARID AREAS,**
Ministry of Agriculture and Water, Riyadh (Saudi Arabia).
For primary bibliographic entry see Field 2D.
W88-05142

**GREEN-AMPT--MODEL TO PREDICT SURGE IRRIGATION PHENOMENA,**
Arizona Univ., Tucson. Dept. of Agricultural Engineering.
M. A. Killen, and D. C. Slack.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 575-584, November 1987. 4 fig, 3 tab, 20 ref.

Descriptors: *Green-Ampt model, *Surge irrigation, *Model studies, *Infiltration, *Furrow irrigation, *Irrigation management, Mathematical equations, Irrigation, Prediction, Wetting, Runoff, Soil properties.

A significant advantage attributed to surge flow irrigation is that for the same volume of water applied the stream will advance farther along the furrow than with continuous flow. Where this advance phenomenon exists, the reduction in runoff and deep percolation will improve uniformity and application efficiency. The mechanism for improvement in advance time has generally been ascribed to surface sealing and surface layer consolidation. However, these phenomena do not satisfactorily explain improved advance times in sandy soils. The Green-Ampt model combined with a simple redistribution model is used to illustrate the effects of reduced wetting front suction due to intermittent wetting on the instantaneous infiltration rate on two soils. The effect of various surge cycle times on the volume infiltrated versus time is also predicted by the model. This approach to modeling infiltration under surge irrigation shows considerable potential for determining the effect of surge irrigation on a range of soil textures, and as a design tool for optimizing surge cycle times. (Author's abstract)
W88-05143

**UPWARD INFILTRATION EQUATIONS IN POWER-LAW FORM,**
Hawaii Univ. at Manoa, Honolulu. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W88-05145

**VELOCITY HEAD CONSIDERATIONS FOR TRICKLE LATERALS,**
Arizona Univ., Tucson. Dept. of Agricultural Engineering.
M. Yitayew, and A. W. Warrick.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 611-615, November 1987. 1 fig, 1 tab, 3 ref.

Descriptors: *Pressure head, *Trickle irrigation, *Hydrodynamics, *Flow rate, *Mathematical equations, *Model studies, *Pipe flows, Resistance, Estimating, Velocity, Flow, Irrigation.

The relationship between pressure head and flow rate for laminar and turbulent flow emitters is an important consideration made in the design of trickle irrigation systems. This relationship is given by q = ch to the y power, with q the flow rate of an emitter cu m/s; h the operating pressure head (m), c a coefficient that includes areal and discharge effects, and y an exponent that characterizes the emitter type as to flow regime. The value of the exponent y is important, in that it gives an indication of how uniform the discharge will be for a given range of variability in pressure compensating devices. By combining the above relationship with the Darcy-Weisbach pipe friction loss (resistance) formula, several investigators were able to develop a head loss ratio as a function of length ratios for trickle laterals. The velocity head change is neglected in the total head loss calculation. The required pressure head at the inlet is slightly overestimated when velocity head is neglected, especially for long laterals and laminar flow regime. A simple solution for trickle laterals assuming a continuous porous manifold and evaluating the error in neglecting the change in velocity head for different flow regimes is presented. (Alexander-PTT)
W88-05147

**SPRINKLER EVAPORATION LOSS EQUATION,**
Oregon State Univ., Corvallis. Dept. of Agricultural Engineering.
W. L. Trimmer.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 616-620, November 1987. 1 fig, 3 tab, 3 ref.

Descriptors: *Evaporation, *Nomographs, *Irrigation, *Mathematical equations, *Sprinkler irrigation, Model studies, Estimating, Climate.

There has been steady testing and modeling work over the last 35 years trying to characterize evaporation losses from sprinklers. The Frost evaporation loss nomograph is widely used for this purpose. This nomograph is used in estimating spray losses at known climatic and operating conditions. Average daytime conditions for the operating period should be used. Night operation losses can be disregarded, unless wind velocities are high. The example shown gives the losses for 10% relative humidity and 90 deg F air temperature, resulting in a vapor pressure deficit of 0.63 psi. The nomograph is not adapted to computer use. The equation developed provides a simple way to estimate sprinkler evaporation losses. The large expected error of the equation is representative of the lack of precision found when measuring sprinkler evaporation losses. The equation also simplifies comparison of new data and models of sprinkler evaporation losses to over 700 tests previously performed. (Alexander-PTT)
W88-05148

**MODEL FOR CROP ALLOCATION IN RURAL FLOODPLAINS,**
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
T. C. Hannan, and I. C. Goulter.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 114, No. 1, p 1-19, January 1988. 5 fig, 5 tab, 19 ref.

Descriptors: *Model studies, *Flood frequency, *Land use, *Agriculture, *Flood damage, Estimating, Crops, Floods, Probability, Mathematical modeling.

A model for rural land-use allocation in terms of areas allocated to floodwater storage and types of crops grown is presented. The model integrates a dynamic programming formulation with a procedure for recognizing variation in the susceptibility of crops to flood damage with the age of the plant, the possibility of more than one damaging flood in a single growing season, and the possible variation in flood frequency over the growing season. The existence of multiple annual floods is considered by incorporating the expected damage prior to a second flood in a single season into the expected damage calculation for later flood events. Time-dependent susceptibility to damage and variation in flood frequency is handled through the calculation of the joint probability of a particular stage of growth and flood event in discrete intervals in the growing season. (Author's abstract)
W88-05149

**SIZING OF TERMINAL UNITS IN SURFACE IRRIGATION PROJECTS: I,**
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
S. I. Sritharan, W. Clyma, and E. V. Richardson.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 114, No. 1, p 20-37, January 1988. 4 fig, 5 tab, 25 ref. US Agency for International Development Contract AID/NE-C-1351.

Descriptors: *Surface irrigation, *Model studies, *Agriculture, *Water demand, Farming, Irrigation, Mathematical equations, Mathematical models, Causal Processes Theory.

The problem of optimal turnout area size is analyzed using an approach common to the causal processes theory (CPT) of mathematical sociology and to the systems engineering approach. The three basic CPT models with different dependence structures are expanded for application to the problem. The general structure of the CPT model, which is based on the basic Bernoulli trials process, is presented, indicating the factors affecting the receipt of water by farmers. The phenomenon of human and physical interventions in CPT model 2 is characterized by the Bernoulli distribution of Poisson with different probabilities and with constant successive probabilities ratio. For the latter case, sets of parametric curves are given for three levels of prescribed success. In CPT model 3, a methodology is derived for obtaining a given or more fraction of visits to a particular state in a two-state Markov chain model (MCM). These methods enable the parameterization of the level of success in obtaining water successfully by a group of farmers given the group size and the degree of intervention process. By prescribing satisfactory levels of the value for this success probability for a given value of the parameter fo ze degree of cooperation, the optimal group size is obtained. A mean value model is also developed for CPT model 3 with a four-state MCM indicating a sample parametric application. (See also W88-05151) (Author's abstract)
W88-05150

**SIZING OF TERMINAL UNITS IN SURFACE IRRIGATION PROJECTS: II,**
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
S. I. Sritharan, W. Clyma, and E. V. Richardson.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 114, No. 1, p 38-51, January 1988. 2 fig, 7 tab, 10 ref. US Agency for International Development Contract AID/NE-C-1351.

Descriptors: *Cost-benefit analysis, *Surface irrigation, *Model studies, *Agriculture, *Water demand, Farming, Irrigation, Mathematical equations, Cooperatives.

Terminal area process models were used to assess the benefit streams of irrigation projects considering the dynamics of water receipts by farmers. The terminal area processes affect the production performance critically, and, for the case of new irrigation projects, by choosing an appropriate benefit-cost ratio, the corresponding terminal area size n can be determined from the correlation generated between n and the B/C ratio. For irrigation improvement projects such correlation tends to peak at given values of n that can be chosen for further design. The Markov Chain Model (MCM) can be used to assess the nature of the problem in the terminal area and to project the impact of different improvement strategies at the terminal level. The importance of farmer cooperation is demonstrated, and the impact of improving it is demonstrated using typical values of parameters. (See also W88-05150) (Author's abstract)
W88-05151

**FARM AND WATERSHED ECONOMIC IMPACTS OF AGRICULTURAL POLICY. APPROACHES TO REDUCE SOIL EROSION AND SEDIMENTATION,**
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6C.

W88-05199

**DESIGN AND EVALUATION METHODS FOR MAXIMIZING ON FARM EFFICIENCY OF CONVENTIONAL AND SURGE SURFACE IRRIGATION,**
Texas Univ., Austin. Center for Research in Water Resources.
E. T. Smerdon, and A. W. Blair.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-142757/AS. Price codes: A13 in paper copy; A01 in microfiche. Contract No. USGS 14-08-0001-G1129.

Descriptors: *Irrigation systems, *Surface irrigation, *Irrigation efficiency, Surge irrigation, Hydraulics, Infiltration, Modeling infiltrometer, Field testing, Economics, Capital costs, Personal computer software.

This work consolidates several coordinated research efforts aimed at developing methods which can be used by practicing engineers and techniques to design better surface irrigation systems. The theoretical work primarily consisted of developing and verifying both analytical and numerical models of surface irrigation hydraulics and infiltration. These models were then incorporated into the surface irrigation design and evaluation software system. Models were developed where accuracy was commensurate with computational efficiency and minimization of field measured inputs. Field and laboratory experiments were carried out to verify the theoretical developments. Efforts were concentrated on infiltration and physical modeling of surface irrigation hydraulics. The economics of optimal surface irrigation compared with other irrigation methods was investigated. The portion of research addressed to this analyzes six alternative irrigation methods and prepared a PC based spreadsheet template which can be used by agricultural producers to analyze the cost effectiveness of improving irrigation efficiency. An interactive software system which can be used to determine the duration, cycle times, and number of surges which maximize irrigation efficiency for a specific field was developed. This comprehensive software system provides methods for determining all important field parameters with emphasis on minimizing the amount of field data required and at the same time providing options as to which methods are used to determine the required parameters. This system also allows the use of more extensive data sets. (Robinson-USGS)
W88-05232

**WATERING SYSTEM,**
U. Sibbel.
U. S. Patent No. 4,685,827; August 11, 1987, 16 p, 14 fig. Official Gazette of the United States Patent Office, Vol 1081, No 2, p 804, August 11, 1987.

Descriptors: *Patents, *Irrigation design, *Subsurface irrigation, *Soil water, Water supply, Water conveyance, Irrigation engineering, Water pressure, Plant water potential, Pipelines.

An automatic underground plant watering system contains watering cylinders, which are connected to a water supply unit through a closed pipeline system. The water supply unit maintains the supply unit through a closed pipeline system. The water supply unit maintains the supply water at a constant level to permit continual watering of the plant roots in flower pots or plant boxes. The water cylinders contain foam plugs which have cohering pores to prevent the penetration of soil from the roots into the watering channel and to retard root growth into the channel. The quantity of water supplied to the roots is controlled by the water pressure in the pore space around the roots and by adjusting the reference level of water in the pipeline system connected to the water supply unit. As the water content of the soil decreases, the suction intensity of the soil water increases and the water flows out of the water supply sockets to reach the pore space of the soil. Conversely, with an increase of water content of the soil, the suction intensity of the soil water decreases. (Cremmins-AEPCO)
W88-05239

**POROUS IRRIGATION PIPE PREPARED FROM PARTICULATE ELASTOMER AND THERMOPLASTIC BINDER CONTAINING CONTROLLED MOISTURE CONTENT,**
Dasurant Enterprises PTE Ltd. (Singapore).
J. W. Mason.
U. S. Patent No. 4,517,316; May 14, 1985, 8 p, 5 fig, 1 tab. Official Gazette of the United States Patent Office, Vol 1054, No 2, p 843, May 14, 1985.

Descriptors: *Patents, *Pipes, *Irrigation engineering, *Subsurface irrigation, *Drip irrigation, Porosity, Moisture content, Crop production, Elastomers, Rubber, Lubricants.

Porous irrigation pipe, with particular application to underground drip or continuous irrigation of densely packed crops, is prepared from particulate elastomer and thermoplastic binder containing controlled moisture content. A pelletizable mixture consists of a major portion of elastomer in crumb form, a slip agent, preferably a mineral such as talc, and a lubricant, such as a metal stearate. The elastomer is cis-1, 4-polyisoprene or synthetic homopolymers of butadiene or isoprene or their copolymers with minor amounts of 0.1 to 20% by weight of vinyl monomers, such as styrene, isobutylene or acrylonitrite. The elastomer is vulcanized. The rubber is ground into crumb particles no larger than those passing through a 10-mesh screen. The binder resin is a thermoplastic material capable of softening at a temperature below 300 F, so that pores will form during extrusion. Styrene polymers, including impact polystyrene copolymers, are useful as the resin, as are nylons, polyvinylchloride, polyphenylene oxide and polyphenylene sulfide polymers. The slip agent aids in extruding the rubber binder mixture. Finely divided materials other than talc can be utilized, such as clays, silicas, carbonates, or micas. The metal stearate lubricant can be selected from calcium, magnesium, or zinc stearates. (Cremmins-AEPCO)
W88-05240

**RISER ASSEMBLY FOR A SUB-SURFACE IRRIGATION AND DRAINAGE SYSTEM,**
J. I. Warner.
U. S. Patent No. 4,678,367; July 7, 1987, 7 p, 8 fig, 4 ref. Official Gazette of the United States Patent Office, Vol 1080, No 1, p 247-248, July 7, 1987.

Descriptors: *Patents, *Subsurface irrigation, *Irrigation engineering, *Pipelines, *Drainage systems, Drainage engineering, Weirs, Tile drains, Polymers.

A riser assembly for a subsurface irrigation and drainage system contains a tile pipeline and a divider with slidable gate valves to control the drainage and weir openings. The riser housing defines a generally rectangular, hollow elongated upwardly opening cavity and contains two tile sections mechanically interlocked with the material forming the housing. The housing is formed of a molded fiberglass material and the tile sections are formed of a polyethylene material. The fiberglass material is molded into external corrugations of the tile sections such that when the fiberglass material has cured the sections are mechanically and permanently interlocked with the housing. Polyvinylchloride, metal, and corrugated metal can also be used with the riser assembly. Disposed within the housing is a divider extending parallel to the sides of the housing and dividing the elongated cavity into an upstream chamber communicating with the upstream tile section and a downstream chamber communicating with the downstream tile section. The divider and the gate valves may also be fabricated from a polyethylene material. (Cremmins-AEPCO)
W88-05241

**DRIP IRRIGATION SYSTEM,**
R. D. Chapin.
U. S. Patent No. 4,626,130; December 2, 1986, 13 p, 8 fig. Official Gazette of the United States Patent Office, Vol 1073, No 1, p 289, December 2, 1986.

Descriptors: *Patents, *Drip irrigation, *Water conveyance, Subsurface irrigation, Irrigation engineering, Surface irrigation, Water pressure, Pressure distribution, Tubes, Fluid flow.

An elongated fluid distributing hose is applied in a trickle irrigation system for plants and vegetables to water large areas uniformly with readily available water pressures. The pressure is substantially maintained throughout the length of the tube without requiring extremely small orifices, which easily clog from impurities. First, second, and third fluid passages enable the maintenance of relatively high pressure throughout the length of the hose and the reduction of this pressure directly at the point that the water passes from the high pressure first fluid passage through a series of passing openings to the much smaller second fluid passage. A further pressure reduction occurs as the water passes within the third fluid passage between a series of second fluid-passing and discharge openings. Thus, the hydraulic principle of flow of fluids passing through an orifice is combined with that of the flow of fluids moving through a slender tubular member in a simple, relatively inexpensive hose design having a single cross-sectional profile throughout its length. (Cremmins-AEPCO)
W88-05244

**PREDICTIONS OF FIELD PRODUCTIVITY FOR AGAVE LECHUGUILLA,**
Centro de Investigacion en Quimica Aplicada, Saltillo (Mexico).
For primary bibliographic entry see Field 2I.
W88-05368

**RUNOFF IMPOUNDMENT FOR SUPPLEMENTAL IRRIGATION IN TEXAS,**
Texas Agricultural Experiment Station, Temple. Blackland Research Center.
J. H. Krishna, G. F. Arkin, and J. R. Martin.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1057-1061, December 1987. 3 fig, 3 tab, 15 ref.

Descriptors: *Supplemental irrigation, *Runoff impoundment, *Agricultural hydrology, *Irrigation, *Runoff, Surface runoff, Irrigation water, Economic aspects, Costs, Water demand, Hydrology, Reservoirs, Water conservation, Water costs, Texas.

The current increase in the demand for water by municipal, industrial, and other users is likely to result in approximately one-third less water being available for agricultural use in Texas by the year 2000. As water supplies diminish, the rainfall excess needs to be used more efficiently. Large amounts of runoff occur in the eastern part of Texas that could be collected in small impoundments and utilized for crop production. Farmers in water-surplus basins or subbasins can apply for a permit to divert surface water into small on-farm impoundments to be used for supplemental irrigation. The costs for runoff collection and two supplemental irrigations, which amount to a total of 4 inches/year, are estimated to be approximately 60 dollars/acre/year. Depending upon the crop produced, the estimated increase in gross income from supplemental irrigation ranges from about 80 dollars to more than 100 dollars per acre annually. (Author's abstract)
W88-05407

**AGGREGATE MARGINAL RETURNS FROM WESTERN IRRIGATED AGRICULTURE,**
Idaho Univ., Moscow. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6D.
W88-05415

**INFLUENCE OF DROUGHT STRESS ON 14-CO2 FIXATION AND ASSIMILATION, AND DISTRIBUTION OF PHOTOSYNTHATES IN WHEAT SEEDLINGS (INFLUENCE DU DEFICIT HYDRIQUE SUR LA FIXATION, L'ASSIMILATION DE 14CO2 ET LA DISTRIBUTION DES PHOTOSYNTHETATS CHEZ JEUNES PLANTES DE BLES),**
Centre National de la Recherche Scientifique, Orsay (France).

For primary bibliographic entry see Field 2D.
W88-05578

**WATER DUTY: BASIS FOR WATER ALLOCATION,**
Arizona Univ., Tucson. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 6E.
W88-05657

**LEGAL CONSTRAINTS ON THE STATE OF KANSAS IN IMPOSING CONSERVATION PRACTICES ON HOLDERS OF EXISTING AGRICULTURAL WATER RIGHTS,**
Kansas Univ., Lawrence. School of Law.
For primary bibliographic entry see Field 6E.
W88-05659

**LEGAL RECOGNITION OF RIGHTS TO GROUND WATER STORED INCIDENTLY BENEATH A SURFACE IRRIGATION PROJECT - NEBRASKA'S LEGAL EXPERIMENT,**
Crosby, Guenzel, Davis, Kessner and Kuester, Lincoln, NE.
For primary bibliographic entry see Field 6E.
W88-05662

**IRRIGATION WATER ALLOCATION IN SOUTH DAKOTA,**
South Dakota State Univ., Brookings. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 6E.
W88-05663

**CHANGING AGRICULTURAL PROPERTY RIGHTS IN THE ENVIRONMENTAL ERA,**
Purdue Univ., Lafayette, IN. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6E.
W88-05670

**REGULATIONS FOR PROTECTING GROUNDWATER AGAINST AGRICULTURAL POLLUTANTS,**
Wisconsin Univ., Madison. Law School.
For primary bibliographic entry see Field 6E.
W88-05671

**FEDERAL RECLAMATION PROGRAM: AN ANALYSIS OF RENT-SEEKING BEHAVIOR,**
Washington Univ., Seattle. Dept. of Economics.
For primary bibliographic entry see Field 6E.
W88-05681

**WATER PRICING AND RENT SEEKING IN CALIFORNIA AGRICULTURE,**
California Univ., Davis. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6E.
W88-05682

**OVERVIEW OF CONSERVATION TILLAGE,**
Purdue Univ., Lafayette, IN.
J. V. Mannering, D. L. Schertz, and B. A. Julian.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 3-17, 2 fig, 7 tab, 14 ref.

Descriptors: *Conservation tillage, *Agricultural practices, *Soil conservation, *Water conservation, Cultivation, Erosion, Soil water, Interstitial water, Soil porosity.

Conservation tillage is defined as any tillage and planting system that maintains at least 30% of the soil surface covered by residue after planting to reduce soil erosion by water; or where soil erosion by wind is the primary concern, maintains at least 450 kg (1,000 lbs) per acre of flat small grain residue equivalent on the surface during the critical erosion period. Types of conservation tillage are: (1) No-till or slot planting; (2) Ridge-till (includes no-till on ridges); (3) Strip-till; (4) Mulch-till; and (5) Reduced-till. Conventional tillage refers to the combined primary and secondary tillage operation normally performed in preparing a seedbed for a given crop grown in a given geographical area. Since operations vary considerably under different climatic, agronomic and other conditions, the definition also varies from one region to another. Conventional tillage is often used as the 'standard' or 'check' in experiments to assess the potential of other systems in a given area. It involves a set of operations that prepares a seedbed having essentially no plant residue left on the soil surface. Many conventional systems leave the surface bare, particularly those based on the use of the moldboard plow. However, a bare soil surface can be achieved with other tools, depending on the previous crop, amount of surface residue, and number and timing of tillage operations. The principal objectives of this workshop were to evaluate the environmental impacts of conservation tillage on surface and groundwater quality. Since one of the major effects of 'conservation tillage' compared to conventional tillage is to reduce soil and/or water loss, those tillage-induced factors that have significant impacts are discussed. Major factors would include surface residue cover in relation to timing of erosive weather conditions, surface roughness, soil porosity, and pore-size distribution. The most significant factor affecting soil and water loss is crop residue cover. The contrast between conservation and conventional tillage as to their effects on percent cover is discussed. Included are the interactions between tillage system and crop species, and the effect of extent and timing of tillage on percent cover. (See also W88-05759) (Lantz-PTT)
W88-05760

**OVERVIEW OF PEST MANAGEMENT FOR CONSERVATION TILLAGE SYSTEMS,**
Iowa State Univ., Ames.
For primary bibliographic entry see Field 5B.
W88-05761

**SOIL CHEMICAL AND BIOLOGICAL PROPERTIES AS AFFECTED BY CONSERVATION TILLAGE: ENVIRONMENTAL IMPLICATIONS,**
Ohio State Univ., Wooster. Agricultural Technical Inst.
For primary bibliographic entry see Field 4C.
W88-05766

**EFFECT OF CONSERVATION TILLAGE ON BIOLOGICAL AND CHEMICAL SOIL CONDITIONS: REGIONAL AND TEMPORAL VARIABILITY,**
Kentucky Univ., Lexington.
For primary bibliographic entry see Field 4C.
W88-05767

**MANURE MANAGEMENT WITH CONSERVATION TILLAGE,**
Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 4C.
W88-05774

**IRRIGATION DEVELOPMENT PLANNING: AN INTRODUCTION FOR ENGINEERS.**
For primary bibliographic entry see Field 6A.
W88-05831

**INTRODUCTION: PLANNING OF IRRIGATION DEVELOPMENT,**
Southampton Univ. (England). Inst. of Irrigation Studies.
For primary bibliographic entry see Field 6A.
W88-05832

**ESTIMATION OF SURFACE WATER RESOURCES,**
For primary bibliographic entry see Field 6A.
W88-05833

**ESTIMATION OF GROUNDWATER RESOURCES,**
Royal Military Coll. of Canada, Kingston (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 4B.
W88-05834

**LAND RESOURCE ASSESSMENT FOR IRRIGATION,**
Land Resources Development Centre, Surbiton (England).
A. J. B. Mitchell, and R. B. King.
IN: Irrigation Development Planning: An Introduction for Engineers. John Wiley and Sons, New York, New York. 1987. p 75-113, 3 fig, 7 tab, 38 ref.

Descriptors: *Irrigation water, *Land resources, *Irrigation practices, *Management planning, *Water resources development, Soil water, Hydraulic permeability, Soil salinity, Sodium, Soil texture, Remote sensing, Data acquisition, Soil profiles, Mapping.

Soil surveys have come to be regarded as a necessary prerequisites for all agricultural developments, particularly where irrigation is concerned but the findings are often disregarded or overridden by other considerations. There are two causes of this: (1) the soil surveyors often pay too little regard to emphasizing the true significance of their findings, (2) the immediate considerations of simplicity and cheapness of the layout are allowed to take priority over less obvious and longer-term management considerations. Two ways in which the relevance and quality of soil surveys can be improved, are: (1) by matching surveys to the requirements; and (2) by introducing a more quantitative approach to soil surveys. Exploratory or reconnaissance surveys, covering large areas at small scale, are necessary for national or regional development strategy. The information collected is of a general nature, suitable for decisions on the direction of research efforts, or the initiation of more detailed studies for specific developments. Semi-detailed surveys are done in areas, often selected following reconnaissance, where a specific development is proposed. Their purpose is to determine the feasibility of the project. Quantification can be achieved through evaluations of: permeability, soil texture, soil salinity and exchangeable sodium, soil standard stability, soil moisture relationships, more quantified soil mapping and reporting, and the use of remote sensing. Available panchromatic aerial photography will probably remain the basis for most land resource surveys for irrigation, because of the large-scale imagery needed for most irrigation projects. Reconnaissance surveys for larger projects could use satellite imagery in the preliminary stages, and radar should be considered in areas with persistent cloud cover. Satellite imagery supported by ground information can be used to monitor crop growth, flooding, and possibly soil moisture and groundwater movements in larger irrigated areas. (See also W88-05831) (Lantz-PTT)
W88-05835

**ESTIMATION OF IRRIGATION WATER REQUIREMENTS,**
Southampton Univ. (England). Inst. of Irrigation Studies.
Z. J. Svehlik.
IN: Irrigation Development Planning: An Introduction for Engineers. John Wiley and Sons, New York, New York. 1987. p 115-143, 2 fig, 9 tab, 23 ref.

Descriptors: *Irrigation programs, *Irrigation requirements, *Mathematical equations, Water requirements, Seasonal variation, Agricultural practices, Precipitation, Root zone, Soil water, Evapotranspiration, Hydrologic budget.

Irrigation water requirements have been defined as the quantity of water that must be supplied by irrigation to satisfy evapotranspiration, leaching and miscellaneous water requirements that are not provided by water stored in the soil and precipitation that enters the soil. The definition refers to the situation where irrigation is used for optimizing the soil moisture conditions for the plant in the root

zone, salinity control, frost protection, plant cooling, puddling, etc. The problems of estimating the irrigation water requirements for controlling the soil moisture regime are discussed. Data required at different irrigation project phases include: average seasonal water supply, seasonal supply of main crops, monthly or 10-day total supply, monthly peak supply, 5- to 10-day peak supply, and water budget in farmer's field. Greatest effort has been directed toward the evaluation of evapotranspiration (ET). A number of ET formulae have been developed, especially for estimating the ET, when energy is a limiting factor. These formulae can be successfully applied to similar conditions under which they were derived. There is no method of ET estimation which has a general validity, and which can be used in practice, without local or regional calibration. Methods of evaluating components other than ET need to be improved. Further research should be directed to a study of soil water dynamics on irrigated fields and evaluation of the upward flux into the root zone. The same applies to the effectiveness of rainfall and irrigation efficiencies. (See also W88-05831) Lantz-PTT)
W88-05836

**ESTIMATION OF IRRIGATION SYSTEM CAPACITY,**
Southampton Univ. (England). Inst. of Irrigation Studies.
Z. J. Svehlik.
IN: Irrigation Development Planning: An Introduction for Engineers. John Wiley and Sons, New York, New York. 1987. p 145-160, 9 fig, 10 ref.

Descriptors: *Irrigation requirements, *Water requirements, *Mathematical studies, Water supply, Costs, Economic aspects, Irrigation water, Irrigation practices.

The principal factor which determines the size and consequently the cost of an irrigation system is the design discharge in the network. Evaluation of its magnitude presents many serious problems. These are due to its dependence on many complex design variables and operating conditions, characterized by a great uncertainty. Methods of estimating the irrigation system capacity are considered with respect to: the irrigation water requirements and their variability in space and time, and the methods of water delivery. The water delivery based on continuous flow can be efficient if used for large irrigation systems or for irrigation of rice. If water supply and the size of the farm are small, the efficiency of water use is usually low. The rotation method (where water is delivered to each farm or block of fields according to a prearranged schedule) can be efficient if a good standard of management and operation is secured. Only limited data about the fluctuations in demand for water are available. This is the main obstacle for finding the correct design capacity of the 'on demand' system. The problem of estimating the design discharge is very complex. The reliability of the results depend very much on the availability and reliability of data. The accuracy of the predictions can be improved by using the mathematical simulation models which allow for an analysis of the variability of irrigation water requirements. (See also W88-05831) Lantz-PTT)
W88-05837

**SOCIAL ASPECTS OF IRRIGATION DEVELOPMENT,**
Southampton Univ. (England). Inst. of Irrigation Studies.
For primary bibliographic entry see Field 6B.
W88-05838

**HEALTH ASPECTS OF IRRIGATION DEVELOPMENTS,**
Southampton Univ. (England). Dept. of Civil Engineering.
P. F. Hillman.
IN: Irrigation Development Planning: An Introduction for Engineers. John Wiley and Sons, New York, New York. 1987. p 177-199, 1 fig, 8 tab, 23 ref.

Descriptors: *Public health, *Irrigation practices, *Water resources development, Wastewater irrigation, Impaired water use, Water quality control, Parasites, Schistosomiasis, Malaria, Filariasis, Onchocerciasis.

Famine and malnutrition can only get worse unless there is a concerted effort at both redistribution of food on a global scale in the short term and massive investment in the development of more cultivated land, in the rehabilitation of existing irrigation schemes and improvements in the management of irrigation projects in the long term. Irrigation developments of various forms are therefore essential. In many regions, the scarcity of water makes its conservation a matter of survival for the population. The reuse of wastewater in agriculture is therefore to be expected and, with adequate safeguards, to be encouraged. Safeguards should include appropriate pretreatment of the wastewater, identification of the specific health impacts such reuse might have, and complementary programs which seek to improve standards of hygiene and the level of health education within the community, and to prevent the spread of parasitic disease such as schistosomiasis, malaria, filariasis and onchocerciasis. Vital to the success of these schemes is an understanding of the social and cultural attitudes toward reuse so that appropriate agricultural practices can be adopted. (See also W88-05831) Lantz-PTT)
W88-05839

**IRRIGATION PROJECT APPRAISAL,**
Southampton Univ. (England). Inst. of Irrigation Studies.
For primary bibliographic entry see Field 6B.
W88-05840

**PROJECT TECHNOLOGY AND PROJECT OPERATION,**
Southampton Univ. (England). Inst. of Irrigation Studies.
J. R. Rydzewski.
IN: Irrigation Development Planning: An Introduction for Engineers. John Wiley and Sons, New York, New York. 1987. p 229-237.

Descriptors: *Irrigation practices, *Irrigation programs, *Technology, *Irrigation operation, Headworks, Water distribution, Water conveyance, Irrigation, Irrigation design.

The main components of an irrigation project, namely the headworks, the distribution system and the system of water application in the field, have to be considered in turn, with comments on specific management problems relating to their operation. The irrigation project is seen as representing a dynamic entity calling for flexibility of initial design and for responsiveness of management to forces internal and external to the project. For clarity, it may be useful to distinguish between two fundamental elements of the development and management of water resources for irrigation. The first concerns the creation of a regulated and guaranteed flow of water (to a given level of acceptable risk) and its delivery to the cropped land. The second deals with the distribution of this flow throughout the project area, its application to the crop root zone and the removal of excess water. These two elements can be physically coincidental, as in the extreme case of the exploitation of groundwater underlying irrigable land, or separated by hundreds of kilometers, as in major river systems such as those of the Nile or of the Indus. In the Indus River system, the management of the engineering works providing the regulated flow of water has to be highly sophisticated (computer models are often used) and is in effect a separate activity from the management of the irrigated agricultural enterprise using this facility. The people operating the headworks do, of course, have an interest in the efficiency of irrigation projects downstream since they are concerned with optimizing the allocation of water at their disposal. However, provided the water deliveries to the project area are maintained within the stipulated limits, downstream project management would not normally be interested in the details of the operation of such a remote headwork facility. (See also W88-05831) Lantz-PTT)
W88-05841

**FEASIBILITY REPORT,**
Halcrow (William) and Partners, Swindon (England).
For primary bibliographic entry see Field 6A.
W88-05842

# 4. WATER QUANTITY MANAGEMENT AND CONTROL

## 4A. Control Of Water On The Surface

**FLOOD FREQUENCY ESTIMATES IN SOUTHEASTERN ARIZONA,**
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
W. C. Boughton, K. G. Renard, and J. J. Stone.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 469-478, November 1987. 4 fig, 5 tab, 10 ref.

Descriptors: *Design floods, *Model studies, *Watersheds, *Arizona, *Flood frequency, Estimating, Climate, Regional analysis, Drainage, Floods.

The effect of the October 1983 floods in southeastern Arizona, on a previously established generalized envelope for floods expected once in 100 years (Q sub 100) was studied. The design envelope produced more conservative estimates of Q sub 100 than individual data sets find. The design envelope for Q sub 100 is revised to correct for some longer periods of record now available, and to be consistent with floods on a wider range of drainage area than previously considered. Additional design envelopes for floods expected once in 2 years (Q sub 2) and once in 10 years (Q sub 10) are prepared, and the three envelopes are used to provide conservative estimates of flood frequencies on ungaged watersheds in southeastern Arizona with drainage areas between 0.01 sq km and 10,000 sq km. A procedure is presented for developing regional flood frequency estimates that could be used in geographically and climatically homogeneous areas. (Author's abstract)
W88-05136

**CLASSIFICATION OF IRRIGATION WATER CONVEYANCE SYSTEM COMPONENTS,**
Calgary Univ. (Alberta). Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W88-05137

**PLANNING MODEL OF IRRIGATION DISTRICT,**
Universidad Autonomia Chapingo (Mexico). Colegio de Postgraduados.
For primary bibliographic entry see Field 3F.
W88-05141

**MODEL FOR CROP ALLOCATION IN RURAL FLOODPLAINS,**
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W88-05149

**EFFECTS OF WATER LEVEL FLUCTUATIONS ON ALGAL COMMUNITIES OF FRESHWATER MARSHES,**
Iowa State Univ., Ames. Dept. of Botany.
For primary bibliographic entry see Field 2H.
W88-05221

**PREDICTION OF NUISANCE BLUE-GREEN ALGAL GROWTH IN NORTH CAROLINA WATERS,**
North Carolina Univ. at Chapel Hill. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W88-05227

## Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

### Group 4A—Control Of Water On The Surface

**EVALUATION OF SOME EMPIRICAL METHODS FOR FLOOD FREQUENCY ANALYSIS, 2. DATA AND COMPUTER PROGRAMS,**
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W88-05234

**EVALUATION OF PARAMETER ESTIMATION METHOD FOR FLOOD FREQUENCY ANALYSIS: COMPUTER PROGRAMS,**
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W88-05235

**ANNUAL FLOW STATISTICS AND DROUGHT CHARACTERISTIC FOR GAGED AND UNGAGED STREAMS IN IDAHO,**
Idaho Univ., Moscow. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W88-05236

**RISER ASSEMBLY FOR A SUB-SURFACE IRRIGATION AND DRAINAGE SYSTEM,**
For primary bibliographic entry see Field 3F.
W88-05241

**USE OF A DYNAMIC PROGRAMMING TECHNIQUE FOR OPTIMIZING OPERATION OF A REGIONAL WATER RESOURCE SYSTEM,**
North West Water Authority, Warrington (England).
For primary bibliographic entry see Field 5F.
W88-05280

**IMPACT OF DAM RETURNS ON WATER QUALITY - MYTH OR REALITY,**
Compagnie Generale des Eaux, Paris (France).
For primary bibliographic entry see Field 5B.
W88-05281

**BRINGING GREAT SALT LAKE FLOODS UNDER CONTROL,**
Ingersoll-Rand Co., Phillipsburg, NJ.
R. E. Cornman.
Public Works PUWOAH, Vol. 118, No. 9, p 111-113, September 1987.

Descriptors: *Water management, *Flood control, *Lakes, *Water level, Great Salt Lake, Utah, Pumping, Storms, Flood damage.

Beginning in 1982, abnormal precipitation soaked the Wasatch Valley area, causing Utah's Great Salt Lake to reach the highest level in modern recorded history: 4211.65 ft above sea level. The surface area increased from a 1960s low of 1000 sq mi to 2500 sq mi. By 1986 $200 million in flood damage had been generated. When a hoped-for dry year did not materialize, the Utah legislature approved funds for flood control. The project features a pumping station with 3 massive pumps capable of pumping over 1.2 million gpm, collectively, connected with the lake by a canal and located a mile west of the lake at Hogup. Water is pumped upwards 17 ft to the West Desert, where a 500-sq mi lake is being formed. Construction began in September 1986 after delays caused by severe rainstorms. The pump became operational in May 1987. The lake level is expected to fall by 14-16 inches during the first year of pumping, with drops of 7-8 inches in succeeding years until the water level is considered safe. The pumps will remain on standby to prevent future flooding. (Cassar-PTT)
W88-05354

**MULTIVARIATE ASSESSMENT OF PLANT MANAGEMENT IMPACTS ON MACROPHYTE COMMUNITIES IN A SCOTTISH CANAL,**
Glasgow Univ. (Scotland). Dept. of Botany.).
K. J. Murphy, A. M. Fox, and R. G. Hanbury.
Journal of Applied Ecology JAPEAI, Vol. 24, No. 3, p 1063-1079, December 1987. 5 fig, 3 tab, 41 ref.

Descriptors: *Water management, *Weed control, *Aquatic weed control, *Herbicides, *Canals, *Plant management, *Multivariate analysis, Macrophytes, Union Canal, Algae, Scotland, Aquatic plants, Dissolved oxygen, Submerged plants, Floating plants, Potamogeton natans, Diquat, Terbutryne, Lemna, Herbicides.

Aquatic weed control trials were conducted in the Union Canal, Scotland, during 1977-1984. The data were used to test the suitability of a multivariate approach for assessing the impacts of plant management on canal macrophyte communities. Two procedures were used: detrended correspondence analysis (DCA) and two-way indicator species analysis (TWINSPAN). Subtle trends of plant community change were observed. These were related to environmental impacts of weed control by herbicides and cutting and to shading of submerged macrophytes by surface-floating plants. Dissolved oxygen status was significantly negatively correlated with one major axis of the DCA ordination. This axis appeared to reflect a trend of plant community change associated with efficient weed control operations. A second major axis was associated with a hydroseral gradient within the early stages of vegetational change in the canal plant community. The hydroseral age of the plant community was affected by the timing and type of control operations. Sites recently treated for weed control were dominated by opportunistic species such as rapid-growing filamentous algae. Fewer opportunistic species were seen in untreated sites, sites sampled long after control operations, and sites where weed control was not effective. Floating-leaved, rooted vegetation (Potamogeton natans) was resistant to weed control. Acceptable weed control with minimum changes in macrophyte community structure was attained by repeated cutting and early season diquat-alginate application. Suboptimal diquat-alginate or terbutryne treatments and late-season cutting increased the abundance of opportunistic species and Lemna spp. and reduced diversity of the plant community (Cassar-PTT)
W88-05369

**INTAKE OPERATION FOR DEEP COOLING RESERVOIRS,**
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
E. E. Adams, and R. Schweikart.
Journal of Energy Engineering JFEED9, Vol. 113, No. 2, p 37-49, September 1987. 6 fig, 4 tab, 20 ref, Append.

Descriptors: *Water management, *Reservoir operation, *Hydraulic structures, *Intakes, *Cooling water, Electric powerplants, Cost analysis, Deep water, Mixing, Model studies, Hydrothermal studies, Stratification, Thermal stratification, Reservoirs.

Mathematical hydrothermal modeling was applied to five hypothetical reservoirs located in Augusta, Georgia, to study the effects of submerged intakes for powerplant cooling water. For the base case reservoir (average depth, 30 ft; surface area, 2000 acres; areal loading, 0.99MWt/acre) and a range of vertical mixing parameters, the intake temperatures from April to October decreased by an average of 0.7-1.2 F using a submerged intake as compared with a surface intake. Estimated energy savings were 1.2 million to 20.4 million kWh annually ($700,000-$11.6 million). The variation was a result of a range of assumed turbine performance curves and cost parameters. Savings increased as the reservoir area and depth increased and vertical mixing decreased. In most cases, performance also improved with combined use of a surface and a submerged intake, using the surface intake during initial periods of the annual stratification cycle. (Cassar-PTT)
W88-05373

**COMPARISON OF RESERVOIR LINEAR OPERATION RULES USING LINEAR AND DYNAMIC PROGRAMMING,**
Louisville Univ., KY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W88-05404

**USE OF STREAMFLOW INCREASES FROM VEGETATION MANAGEMENT IN THE VERDE RIVER BASIN,**
Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
For primary bibliographic entry see Field 3B.
W88-05419

**RESCUING THE EVERGLADES,**
South Florida Water Management District, West Palm Beach. Dept. of Resource Management.
T. K. MacVicar.
Civil Engineering CEWRA9, Vol. 57, No. 8, p 40-42, August 1987. 2 fig.

Descriptors: *Water management, *Flood control, *Everglades, *Streams, Flow control, Drainage, Florida, Swamps, Tamiami Trail, Rainfall, Water storage, Wetlands, Overland flow, Shark River Slough, Aquatic habitats, Habitats, Ecosystems.

The Rainfall Plan is a strategy to deal with floods and droughts in the Florida Everglades by returning the water flows to their natural rhythms without flooding cities and farms which have encroached in recent years. By 1963 the Southern Florida Flood Control Project had converted the Everglades into a controlled system of water storage areas and drained lands. This management plan cut off the eastern section from the overland flow during dry periods and profoundly affected the ecology of the area. In flood years the strategy flooded alligator nests and discouraged wading birds from nesting. The new plan has three objectives: (1) Return the Shark River Slough hydrology to its historic response and real-time conditions; (2) Reduce the sudden changes in flow to the Park caused by strict enforcement of the previous regulations; (3) Restore the historic distribution to the Shark River Slough by diverting half the flow to its northeast quadrant. To implement the Rainfall Plan, the data base had to be enlarged, the Shark River Slough management scheme had to be refined, and another water control structure (S-333) was built in 1978. This allows water to be released through 53 culverts under the Tamiami Trail to restore flow to a more historical pattern. Analysis of the first year's test results showed that the overland flow to the eastern section was re-established except for two weeks in September 1985. (Cassar-PTT)
W88-05475

**AQUATIC WEED PROBLEMS IN A HYDROELECTRIC RIVER: THE RIVER OTRA, NORWAY,**
Norsk Inst. for Vannforskning, Oslo.
B. Rorslett.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 1, p 25-37, January-March 1988. 5 fig, 4 tab, 34 ref.

Descriptors: *Acidic water, *Dam effects, *Macrophytes, *Aquatic weeds, Water level fluctuations, Otra River, Hydroelectric power, Water resources development, Reservoirs.

Excessive abundance of submerged macrophytes is a less well-known but highly undesirable effect resulting from hydropower development. An example is the acidic River Otra, which is an extensively exploited hydroelectric river located in a region of infertile soils in southern Norway. The operating schemes annually generate some 4.1 TWh of hydropower. Many stretches of the River Otra support massive infestations of a submerged phenotype of Juncus bulbosus L. Evidence from a multidisciplinary study demonstrates that proliferation of J. bulbosus is achieved under an altered flow regime typical of Norwegian hydro rivers. The main features are augmented winter flows, concomitant lack of ice-cover, and intermediate ranges and frequencies of water-level fluctuation. These hydrological conditions prevail in tailwaters and intermediate-type hydro lakes on the Otra. By contrast with the Otra River, an adjacent watercourse, the acidified Tovdal River, supported only scattered J. bulbosus in its upper, non-regulated sections, whereas a hydro lake on the lower Tovdal River had locally abundant growth of J.

bulbosus. Acidification per se is an unlikely determinant of profuse growth for this species: non-natural habitats created by hydropower operation provide vacant space for an opportunistic species such as J. bulbosus. (Author's abstract)
W88-05551

**CHANGES IN THE PHYSICO-CHEMISTRY AND BENTHIC INVERTEBRATES OF THE GREAT FISH RIVER, SOUTH AFRICA, FOLLOWING AN INTERBASIN TRANSFER OF WATER,**
J. H. O'Keeffe, and F. C. DeMoor.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 1, p 39-55, January-March 1988. 6 fig, 7 tab, 35 ref.

Descriptors: *Interbasin transfer, *Flow patterns, *Invertebrates, *Benthic fauna, *Benthic fauna, *Seasonal variation, *South Africa, Erosion, Habitats, Alkalinity, Sodium, Magnesium, Chloride, Sulfates, Calcium, Livestock, Annual runoff.

Data on the hydrology, chemistry, and benthic invertebrates of the Great Fish River prior to the opening of the Orange River/Fish River interbasin water transfer scheme in 1977, are compared with similar data for post-transfer conditions. As a result of the transfer of water, the once irregular seasonal flow of the Fish River has now become perennial. The mean annual runoff of the upper river has increased by between 500 and 800 percent. Mainly because of abstractions for irrigation, the mean annual discharge of the lower river has changed little, but seasonal flow variation in the lower river has been considerably reduced. The inflow of low salinity water from the Orange River has diluted the highly mineralized Fish River water, reducing concentrations of sodium, magnesium, chloride and sulfate, but not of calcium or total alkalinity. The invertebrate communities of riffles have changed substantially as a result of the water transfer, and only 33 percent of taxa identified were common to both pre- and post-transfer surveys. In particular, the dominant chironamid, hydropsychid, and simuliid species have changed, although there is not evidence that overall invertebrate densities have been altered. The most striking change in the fauna has been the replacement of the pre-transfer dominant simuliids (Simulium adersi and S. nigritarse) by S. chutteri, a blood-feeding pest of livestock, which now causes considerable problems to farmers. The major changes in invertebrate species can be attributed to the more permanent flow and increased area of erosional habitats. (Author's abstract)
W88-05552

**COMPARATIVE ASPECTS OF COMPUTERIZED FLOODPLAIN DATA MANAGEMENT,**
Middlesex Polytechnic, London (England). School of Geography and Planning.
For primary bibliographic entry see Field 6A.
W88-05611

**REAL-TIME FLOOD MANAGEMENT MODEL FOR HIGHLAND LAKE SYSTEM,**
Texas Univ., Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W88-05638

**SURFACE WATER FEES USED TO REDUCE URBAN FLOODING,**
King County Dept. of Public Works, Seattle, WA.
For primary bibliographic entry see Field 6F.
W88-05650

**INSTREAM WATER USE: PUBLIC AND PRIVATE ALTERNATIVES,**
Lewis and Clark Coll., Portland, OR. Natural Resources Law Inst.
For primary bibliographic entry see Field 6E.
W88-05687

**WALNUT CREEK FLOOD-CONTROL PROJECT, CONTRA COSTA COUNTY, CALIFORNIA,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W88-05709

## 4B. Groundwater Management

**MAJOR WATER RESOURCE PROBLEMS AND PROJECTS IN CHINA,**
Chengdu Univ. of Science and Technology (China). Dept. of Hydraulic Engineering.
For primary bibliographic entry see Field 6D.
W88-05157

**BASINWIDE WATER-BALANCE MODELING WITH EMPHASIS ON SPATIAL DISTRIBUTION OF GROUND WATER RECHARGE,**
Kansas State Geological Survey, Lawrence.
M. Sophocleous, and J. A. McAllister.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 997-1010, December 1987. 15 fig, 20 ref.

Descriptors: *Hydrologic budget, *Groundwater recharge, *Soil-water-plant relationships, *Vegetation effects, *Evapotranspiration, *Hydrologic models, Model studies, Spatial distribution, Groundwater, Vegetation, Land use, Rattlesnake Creek basin, Kansas, Watersheds, Irrigation effects.

A detailed but simple hydrologic budget for the entire Rattlesnake Creek basin (3,768 sq km) in south-central Kansas was developed. With this budget, using minimal daily-weather input data and the soil-plant-water system-analysis methodology, the spatial distribution of the hydrologic components of the water balance within the basin was characterized. A combination of classification and meteorological methods resulted in a basinwide integrations methodology. Using this methodology it was found that, in addition to obvious climatic controls, soil, vegetation, and land-use factors also exert considerable influence on the water balance of the area. The available-water capacity (AWC) of soil profiles plays a dominant role in soil-water-deficit development and deep drainage. Vegetation and dryland or irrigated farming particularly affect the evapotranspiration (ET) components, with ET from irrigated corn and alfalfa being two to three times that from wheat. Deep drainage from irrigated wheat fields was significantly higher than that from grassland and dryland wheat; deep drainage from alfalfa is practically non-existent. Different portions of the watershed have different water-balance components so and that use of single average values of hydrologic variables in management practices may not be realistic. (Author's abstract)
W88-05401

**REGIONAL MANAGEMENT OF DEPLETED AQUIFERS,**
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
W. Whipple.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1179-1184, December 1987. 4 fig, 4 ref.

Descriptors: *Groundwater management, *Aquifer management, *Depleted aquifers, *Coastal aquifers, *Saline water intrusion, Model studies, Regional planning, Aquifers, Water conservation, Hydrologic models, Water supply, Water management, Hydrogeology.

Aquifers with pressure head seriously reduced by overdrafting are referred to as depleted. In coastal areas they may be invaded by saltwater. An obvious remedy is to reduce the rate of withdrawal to the permanently available dependable yield. This is being done now in two areas for New Jersey, under the authority of the State's Water Supply Management Act, but it has not previously been accomplished on a regional scale. The dependable yield was estimated by means of detailed hydrogeological modeling. 'Water Supply Critical Areas' were delineated on the basis of piezometric pressure, drawn down 30 feet below sea level. Within the depleted area, water withdrawals must be reduced by a fixed ratio (35 to 50%) below the amount withdrawn during 1983. This reduction is effective as soon as alternative sources of water can be made available, usually from a surface source. Special arrangements are made whereby ground water users unconnected to the alternative source of supply can pay to withdraw their full needs from the depleted aquifers, the money being used to purchase additional water from the new surface water sources, in return for which some other user will reduce his ground water withdrawal below his reduced allocation. (Author's abstract)
W88-05422

**WATER RESOURCES LAW.**
For primary bibliographic entry see Field 6E.
W88-05654

**LEGAL RECOGNITION OF RIGHTS TO GROUND WATER STORED INCIDENTLY BENEATH A SURFACE IRRIGATION PROJECT - NEBRASKA'S LEGAL EXPERIMENT,**
Crosby, Guenzel, Davis, Kessner and Kuester, Lincoln, NE.
For primary bibliographic entry see Field 6E.
W88-05662

**IMPACT OF CITY OF TEQUESTA VS JUPITER INLET CORPORATION ON FLORIDA ADMINISTRATIVE WATER LAW,**
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 6E.
W88-05665

**HYDROLOGY AND WATER LAW-COOPERATION FOR THE FUTURE,**
Hardt (W.F.) and Associates, Orange, CA.
For primary bibliographic entry see Field 6E.
W88-05676

**SUSTAINED GROUNDWATER YIELD AND CONSUMPTIVE USE VIA TARGET LEVELS IN A REASONABLE USE STATE,**
Arkansas Water Resources Research Center, Fayetteville.
For primary bibliographic entry see Field 6E.
W88-05678

**WATER RIGHTS: SCARCE RESOURCE ALLOCATION, BUREAUCRACY, AND THE ENVIRONMENT.**
For primary bibliographic entry see Field 6E.
W88-05679

**PRIVATIZING GROUNDWATER BASINS: A MODEL AND ITS APPLICATION,**
Montana State Univ., Bozeman. Dept. of Economics.
For primary bibliographic entry see Field 6E.
W88-05686

**MICROCOMPUTER PROGRAMS FOR GROUNDWATER STUDIES,**
For primary bibliographic entry see Field 2F.
W88-05778

**ESTIMATION OF GROUNDWATER RESOURCES,**
Royal Military Coll. of Canada, Kingston (Ontario). Dept. of Civil Engineering.
W. B. Wilkinson, and L. Clark.
IN: Irrigation Development Planning: An Introduction for Engineers. John Wiley and Sons, New York, New York. 1987. p 39-73, 11 fig, 1 tab, 24 ref.

Descriptors: *Groundwater potential, *Water resources development, *Groundwater management, Data interpretation, Groundwater level, Developing countries, Africa, Asia, South America, Aquifers, Groundwater recharge, Groundwater storage, Groundwater quality, Groundwater irrigation.

Although it is extensive, groundwater is often difficult to locate. It may not be present where it is required, may be too deep to develop economically, or it may be of an unsuitable quality for the desired use. The most difficult task is not to determine the presence and quality of the groundwater but to assess the amount of recharge that is taking place, the size of the resource and the amount that is available for use. If its size is overestimated, then overdevelopment will result which may lead to falling water levels, loss of yield in wells, deterioration in water quality and possibly abandonment of the scheme. The place of groundwater within the hydrological cycle and the factors controlling its occurrence and flow are described. If a major groundwater resource is being considered for irrigation it is proposed that four distinct investigation stages may be necessary to evaluate the size of the resource and to select the appropriate method of development. These factors are: (1) The water must be readily accessible; (2) There should be a satisfactory source of recharge to the aquifer, either from surface water bodies, precipitation, or adjacent aquifers; (3) There should be sufficient storage within the aquifer to enable yields to be maintained during periods of drought. The aquifer may thus be regarded as an underground reservoir; and (4) The quality of the water should be such as to make it acceptable for the desired use. However, one of the principal advantages of groundwater is that it can be developed on a very large or very small scale. There are large areas of Africa, South America and Asia where the bedrock may be of low permeability, thus giving only small yields from individual wells. However, these may be of considerable importance for small-scale irrigation or rural water supplies. The flexibility that may be adopted in using groundwater in relation to both the large prestigious projects and the much smaller-scale developments is considered. (See also W88-05831) (Lantz-PTT)
W88-05834

**GROUND WATER MANUAL: A GUIDE FOR THE INVESTIGATION, DEVELOPMENT, AND MANAGEMENT OF GROUND-WATER RESOURCES.**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
For primary bibliographic entry see Field 2F.
W88-05853

## 4C. Effects On Water Of Man's Non-Water Activities

**WATER SUPPLY: POSSIBLE CONSTRAINTS ON SOCIO-ECONOMIC DEVELOPMENT IN OYO STATE OF NIGERIA,**
Nigerian Inst. of Social and Economic Research, Ibadan.
F. Olokesusi.
Aqua AQUAAA, No. 5, p 268-273, 1987. 1 fig, 6 tab, 35 ref.

Descriptors: *Water supply, *Social aspects, *Economic development, *Developing countries, Nigeria, Water supply development, Water quality, Water allocation, Water use, Water policy, Water requirements.

Sufficient water of acceptable quality is required for human nutrition and health, production of goods and services, and social well-being. Nigeria has abundant surface and groundwater resources, but only 23-35% of the population has access to a pipe-borne water supply while the rest rely on wells, streams and rain water. The situation is very critical in rural areas; water-borne diseases are widespread in these areas and over 70% of the population lives in rural settlements. Data published by a governmental agency in 1983 on water supply and consumption were presented. Public health experts claimed the provision of safe drinking water to be the most effective action possible for improvement of human health and productivity in developing nations. Causal factors of water inadequacy in the State of Oyo, Nigeria, including obstacles to the provision of adequate funds, inappropriate technology and lack of water conservation were discussed. It is concluded that the Federal and state governments should allocate reasonable funds to the water agency and that the money be spent judiciously. The programs and technology for water supply to low-income areas must be reviewed with a view to incorporating simpler, cheaper water as well as sanitation programs. (Wood-PTT)
W88-05284

**IMPACT OF RAPID URBANIZATION ON PAN EVAPORATION IN PHOENIX, ARIZONA,**
Arizona State Univ., Tempe. Dept. of Geography.
R. C. Balling, and S. W. Brazel.
Journal of Climatology JOUCD2, Vol. 7, No. 6, p 593-597, November-December, 1987. 1 fig, 2 tab, 25 ref.

Descriptors: *Urbanization, *Pan evaporation, *Phoenix, *Arizona, *Climatology, Construction, Deserts, Distribution, Seasonal distribution, Land use, Dewpoint, Condensation, Humidity, Relative humidity, Evaporation, Temperature, Wind, Weather.

Rapid urbanization in Phoenix, Arizona over the past few decades has been associated with large increases in local temperature and wind speed values, and decreases in local dewpoint and relative humidity levels. The impact of these urban-induced climatic changes on long-term pan evaporation rates is identified. The results indicate an increase from 1917 to 1985 in the local pan evaporation in all months of the year. Following a long period of generally increasing pan evaporation levels, a sharp jump in the pan measurements occurred in the late 1960s. This pronounced discontinuity in the long-term record appears to be associated with the construction of a nearby regional shopping center in 1968. Given widespread similar land-use changes throughout this rapidly growing desert city and the well-documented changes in local climatic conditions, potential evapotranspiration increases are probably occurring throughout much of the metropolitan area. (Author's abstract)
W88-05312

**EFFECT OF URBANIZATION ON SOME CHARACTERISTICS OF RELATIVE HUMIDITY IN IBADAN,**
Ilorin Univ. (Nigeria). Dept. of Geography.
Y. R. Adebayo.
Journal of Climatology JOUCD2, Vol. 7, No. 6, p 599-607, November-December, 1987. 4 fig, 5 tab, 18 ref.

Descriptors: *Urbanization, *Relative humidity, *Ibadan, *Diurnal distribution, *Seasonal distribution, *Spatial distribution, Land use, Humidity, Distribution, Temporal distribution, Climatology, Rainfall, Evaporation, Evapotranspiration, Vegetation, Drainage.

The effect of urbanization on some aspects of the diurnal, seasonal, and spatial patterns of relative humidity in Ibadan was examined. Two approaches were adopted. First, a rural-site station was used as a control, while its 20-year (1961-1980) data were compared with those of the two urban-located stations. Second, isoline maps of the spatial patterns were produced. Occasional, diurnal recordings were carried out at strategic locations over a period of one year. The analyses show that relative humidity was lower within the city than in the rural area. The mean difference varied from 2 to 3% at 0900 h to about 10% at 1500 h. At the peak of the wet season, there was virtually no difference by 0900 h and a difference of just about 5% at 1500 h. At the height of the dry season, whereas the relative humidity was about 3-6% lower in the urban area at 0900 h, the difference was about 12-17% at 1500 h. The isoline maps also reflect the diurnal and seasonal patterns, and the attenuation of relative humidity with increase in the intensity of urbanization. The analyses do not confirm there was any significant decrease in relative humidity over time as a result of the impact of the city-growth. (Author's abstract)
W88-05313

**IMPACT OF ABANDONED WELLS,**
Blasbland and Bouck Engineers, Syracuse, NY.
T. E. Gass.
Water Water Journal WWJOA9, Vol. 42, No. 1, p 48-49, January, 1988.

Descriptors: *Abandoned wells, *Disposal wells, *Water pollution sources, *Oil wells, *Monitoring wells, *Hazards, *Groundwater pollution, Groundwater management, Wells, Aquifers, Contamination, Case studies.

The impact of abandoned wells on groundwater quality and quantity is discussed. It is estimated that there are between two and 20 million abandoned wells in the United States. Newly abandoned domestic water supply wells are often left unplugged to become conduits for cross-contamination between aquifers. Case histories are also described of water wells deteriorating and becoming a source of freshwater discharge, depleting drinking water aquifers. The leakage of contaminated or highly mineralized water through abandoned oil and gas wells and unplugged exploration holes has led to groundwater pollution problems including salinization. Abandoned liquid waste injection wells can become conduits for vertical migration of contaminated liquids to overlying potable aquifers. Education of state and federal agencies, water well contractors, and the general public is required to encourage the proper sealing of abandoned wells. (Doria-PTT)
W88-05314

**IMPACT OF WATERSHED URBANIZATION ON STREAM INSECT COMMUNITIES,**
George Mason Univ., Fairfax, VA. Dept. of Biology.
R. C. Jones, and C. C. Clark.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1047-1055, December 1987. 4 fig, 3 tab, 24 ref.

Descriptors: *Urbanization, *Aquatic insects, *Streams, Watersheds, Populations, Insects, Taxonomy, Midges, Beetles, Caddisflies, Dobsonflies, Stoneflies, Human population, Density, Population density, Benthic fauna, Virginia, Correlation analysis, Ecosystems.

The impact of urbanization on stream insect communities was determined by sampling 22 sites in northern Virginia representing a range of human population densities. Watershed development had little effect on the total insect numbers (no./sq m), but shifted the taxonomic composition markedly. Relative abundance of Diptera (mainly chironomids) increased at more highly urbanized sites, while most other insect orders including Ephemeroptera (mayflies), Coleoptera (beetles), Megaloptera (dobsonflies), and Plecoptera (stoneflies) decreased. Trichoptera (caddisflies) exhibited a variable response. Genus diversity and richness (number of genera) were significantly higher in less urbanized streams. Two genera of chironomids were positively correlated with increased urbanization, while 14 other genera (scattered through several orders) were negatively related to human population density. Principal components analysis demonstrated a gradient from more urbanized to less urbanized stations based on generic and order level biological data. Results indicate that watershed urbanization has a major impact on benthic insect communities even in the absence of point source discharges. (Author's abstract)
W88-05406

**OXIDIZED NITROGEN IN PRECIPITATION, THROUGHFALL, AND STREAMFALL FROM A FORESTED WATERSHED IN OKLAHOMA,**
Geological Survey, Huron, SD. Water Resources Div.
S. J. Lawrence, and P. J. Wigington.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1069-1076, December 1987. 7 fig, 4 tab, 26 ref.

Descriptors: *Forest hydrology, *Forest management, *Water quality, *Mixed forests, *Trees, *Rainfall, *Nitrogen compounds, Nitrogen, Forest watersheds, Clear-cutting, Cutting management, Forests, Oklahoma, Throughfall, Canopy, Nitrites, Nitrates, Streams.

The influence of forest management on water quality was studied due to concern that the type and degree of forest management may affect downstream water quality, particulary as a nonpoint source of nutrients. The precipitation-leaf interaction within a forested watershed may affect the nutrients found in throughfall through leaf wash, foliar uptake and leaching, and ion exchange reactions. Therefore, the possible effects of clearcutting on the water quality of lakes and streams were investigated by determination of the flux patterns of oxidized nitrogen (nitrite + nitrate N) among bulk precipitation, bulk throughfall, and streamflow from March through June 1983 in a 7.86 hectare, forested southeastern Oklahoma watershed prior to clearcutting and forest vegetation conversion. Oxidized nitrogen inputs comparable to the results of other studies were recorded during the 19 rainstorms sampled. Oxidized nitrogen concentrations appeared to increase after rainfall interacted with the pine and hardwood canopies and were inversely related to both rainfall and throughfall depth. Oxidized N concentrations in streamflow were greatest during the rising limb of storm flow with subsequent decreases during the falling limb of storm hydrographs and lowest during base flow. The oxidized N inputs from bulk precipitation were considerably greater than outputs from streamflow resulting in a net retention of oxidized nitrogen within the watershed during the study period. It is concluded that the watershed conserves and recycles incoming nitrogen by storage within the vegetative canopy, but more significantly through biotic activity within the leaf litter/soil body complex. (Wood-PTT)
W88-05409

**MODELING THE EFFECTS OF URBANIZATION ON BASIN WATER YIELD AND RESERVOIR SEDIMENTATION,**
Agricultural Research Service, Temple, TX.
J. G. Arnold, M. D. Bircket, J. R. Williams, W. F. Smith, and H. N. McGill.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1101-1107, December 1987. 3 fig, 7 tab, 16 ref.

Descriptors: *Urbanization, *Water yield, *Reservoir silting, *Sediments, Hydrologic models, Model studies, Dallas, White Rock Lake, Texas, Rural areas, Simulation, Basins, Surface runoff, Sedimentation rates, Land use.

The dam impounding White Rock Lake was completed in 1910 to provide water for the City of Dallas. Since then, land use on the watershed has changed from entirely rural to > 77% urban. A model called SWRRB (Simulator for Water Resources in Rural Basins) was utilized to determine the effect of urbanization on water and sediment entering the lake. The simulation results show that, if urbanization had not occurred, then the annual surface runoff would be 135 mm rather than 151 mm and the annual sediment yield would be 4.4 t/ha rather than 4.1 t/ha. Also, the effect of urbanization on delivery ratios was shown and a positive linear correlation was found. Finally, the weather generator in SWRRB was utilized to estimate the loss of reservoir capacity until 2050 for three different land use management scenarios: (1) no additional urbanization or agricultural land management changes after 1984; (2) the watershed is entirely urban beginning in 1984; and (3) no urbanization on the watershed and continue with 1984 agricultural land use. Reservoir capacity lost to sedimentation was greatest for scenario (3). (Wood-PTT)
W88-05413

**SIMULATION OF THE EFFECTS OF FOREST COVER, AND ITS REMOVAL, ON SUBSURFACE WATER,**
Northern Forest Research Centre, Edmonton (Alberta).
G. R. Hillman, and J. P. Verschuren.
Water Resources Research WRERAO, Vol. 24, No. 2, p 305-314, February 1988. 10 fig, 3 tab, 25 ref.

Descriptors: *Model studies, *Simulation, *Soil water, *Streamflow, *Forest cover, *Forest management, Field tests, Prediction, Estimating, Mathematical studies, Infiltration, Evapotranspiration.

A distributed, physically based mathematical model was developed to simulate the effects of forestry operations on both soil water and streamflow. It combines Galerkin's finite-element method with an implicit backward finite-difference scheme to solve the Darcy-Richards equation of porous media flow, and uses sink concepts to simulate water use by trees. The validity of the model was checked by simulation of one-dimensional vertical infiltration into a soil column. Five forest configurations, imposed on a hillslope, were simulated: fully treed, upper slope clear-cut, lower slope clear-cut, patch-cut, and entire slope clear-cut. The results, displayed as total potential and soil water fields, were qualitatively compatible with accepted hydrological concepts. A field study was simulated and the results compared with field measurements. Explanations are offered for discrepancies between the simulation results and the field measurements. The model's primary usefulness rests in its capability to simulate soil water movement and redistribution, on a distributed basis, in response to the processes of infiltration, evaporation, and transpiration. (Author's abstract)
W88-05444

**FISHING THE FOUR-LANE,**
Montana Dept. of Highways, Helena.
S. Colyer.
Civil Engineering CEWRA9, Vol. 57, N0. 8, p 50-51, August 1987.

Descriptors: *Fisheries, *Highway effects, *Environmental effects, *Stream fisheries, Aquatic habitats, Habitats, Riparian plants, Vegetation, Wilderness areas, Rainbow trout, Trout, Recreation, Montana, Channel improvement, Stream improvement.

The Montana Department of Highways collaborated with the Department of Fish, Wildlife, and Parks on a plan to build a 35.6-mile four-lane highway through wilderness areas popular for recreational trout fishing. It was necessary to rechannel 1.1 miles of Boulder River to make space for the highway. Structures were built in Boulder River and Bison Creek to compensate for lost fish habitat and to provide new habitat. Many shore-anchored structures jutting into the stream were built and planted with native vegetation. A man-made island was created. Artificial rock drop structures, sunken cover and log check dams created new fish holding areas. Holes were excavated in the stream bed and partially covered with 3 to 4-ft boulders. Logs were secured to the bank parallel to the stream flow to protect vegetation along straight reaches. The stream alterations have not been formally evaluated, but fishermen seem satisfied with their catches. (Cassar-PTT)
W88-05477

**DEFORESTATION OF LARGE RESERVOIR BASINS,**
Rua Baronesa de Pocone, Rio de Janeiro (Brazil).
M. P. Paiva.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 1, p 57-60, January-March 1988.

Descriptors: *Water quality, *Reservoirs, *Zoned deforestation, *Biochemical oxygen demand, Costs, Biomass, Floating plants, Aquatic weeds, Reservoir filling.

Possible alternatives regarding deforestation of large reservoir basins are considered, and the convenience of adopting zoned deforestation is favored. At the same time a methodology is developed to estimate the quantity of vegetal biomass to be removed from flooding basins of such reservoirs before closing the respective barrages. Recommendations are made regarding plans for the filling phase, which must be elaborated together with the plans of deforestation, so that mutual adjustments are allowed, attaining maximum reductions in costs and duration of clearing services. It is recommended that the occurrence of trunks emerging from the water should be reduced to a minimum in order to avoid the development of floating aquatic macrophytes. (Author's abstract)
W88-05553

**CITIZEN'S GUIDE TO RIVER CONSERVATION,**
National Park Service, Boston, MA.
For primary bibliographic entry see Field 6A.
W88-05690

**ECOLOGICAL RECOVERY AFTER RECLAMATION OF TOXIC SPOILS LEFT BY COAL SURFACE MINING, PHASE II: AN ASSESSMENT OF ENVIRONMENTAL CHANGES FOLLOWING INTENSIVE REMEDIAL TREATMENTS,**
Tennessee Valley Authority, Norris. Div. of Land and Economic Resources.
T. G. Zarger, D. H. Scanlon, C. P. Nicholson, S. R. Brown, and L. B. Starnes.
Available from the National Technical Information Service, Springfield, VA 22161, as DE87-900612. Price codes: A06 in paper copy, A01 in microfiche. Tennessee Valley Authority Report No. TVA/ONRED/LER--86/59, (1987). Tennessee Valley Authority and EPA Agreement No. D9 E721-DQ.

Descriptors: *Ecological effects, *Coal mines, *Land reclamation, *Toxicity, *Tennessee, Sedimentation, Water quality, Monitoring, Revegetation, Aquatic environment, Succession, Forest watersheds, Birds, Vegetation, Reservoirs.

The early effects of selected remedial land treatments on ecosystem recovery of a forested watershed area impacted by surface mining were evaluated. Some 162 ha within a 2,800 ha watershed in eastern Tennessee was mined between spring 1970 and spring 1972. The toxic nature of the spoil material associated with the coal seams was unknown to the mine operator. Repeated attempts by the operator to revegetate the spoils by conventional measures proved unsuccessful. Two years after mining and reclamation, only 24% of the mined area had become stabilized. An intensive remedial land treatment developed for the essentially bare 125 ha was initiated in fall 1974. Remedial work was planned to complete vegetative establishment over 3 years by treating one-third of the affected area each year. As a result of the remedial treatments and invasion of naturally seeded species, herbaceous ground cover on the impacted minesite increased from 33% in fall 1975 to 78% in fall 1980. Naturally invading vegetation accounted for only 6% of the total cover in 1975, increasing to 21% in 1980. Spread of reclamation and naturally occurring revegetation on the control area that had been characterized as reclaimed in 1974 increased by 27% -- from a total cover of 62% in 1975 to 89% in 1980. Breeding and wintering bird populations increased on all mine sectors, although increases by sectors were not uniform from year to year. Instream water quality that had been degraded by mining began to improve 1 to 2 years following completion of remedial reclamation and was continuing to improve at termination of monitoring in 1980. The average annual rate of sediment deposition in the city water supply reservoir was 2,384 cu m for the 6 years before mining. The rate more than tripled during the 4 years of conventional mining and reclamation. In the ensuing 6-yr period, which reflected results of the remedial treatment, the average annual rate decreased to 3,585 cu m. (Lantz-PTT)
W88-05718

**EFFECTS OF CONSERVATION TILLAGE ON GROUNDWATER QUALITY: NITRATES AND PESTICIDES,**
Ohio State Univ., Columbus. Dept. of Soil Chemistry.
T. J. Logan, J. M. Davidson, J. L. Baker, and M. R. Overcash.
Lewis Publishers, Chelsea, Michigan. 1987. 292 p.

Descriptors: *Nonpoint pollution sources, *Path of pollutants, *Water pollution sources, *Conservation tillage, *Groundwater pollution, *Groundwater quality, *Fate of pollutants, Tillage, Pesticides, Nitrates, Great Lakes, Soil water.

The potential contamination of groundwater, and to a lesser extent surface water, by nitrate and pesticides as a result of widespread shifts from

inversion tillage to conservation tillage, is the focus of this book. Concern for groundwater contamination by agricultural and industrial chemicals commands national attention today. Among these, nitrate and pesticides receive considerable attention because of the large quantities used by farmers and because of the high mobilities of nitrate and some of the pesticides in soil. The question posed here is not whether these compounds migrate to groundwater as a result of agricultural practices, or the extent of groundwater contamination. Rather, the authors were asked to consider whether extensive shifts from inversion tillage to conservation tillage would increase the potential for groundwater contamination by nitrate and pesticides. The first three chapters provide background on the extent of conservation tillage practices as currently used in the United States, and pesticide and nitrogen fertilizer use with conservation tillage. These are followed by a review chapter on nonpoint source pollution in the Great Lakes, with particular emphasis on nitrogen and pesticides. A series of lead and discussion chapters are then presented on effects of conservation tillage on physical, chemical, and biological processes in soil and on surface and groundwater hydrology. The next lead and discussion chapters concern nitrogen and pesticide fate and transformations in soil, and the final chapter is on interactions of conservation tillage and agricultural waste management. (See W88-05760 thru W88-05775) (Lantz-PTT)
W88-05759

**OVERVIEW OF PEST MANAGEMENT FOR CONSERVATION TILLAGE SYSTEMS,**
Iowa State Univ., Ames.
For primary bibliographic entry see Field 5B.
W88-05761

**OVERVIEW OF NITROGEN MANAGEMENT FOR CONSERVATION TILLAGE SYSTEMS: AN OVERVIEW,**
Minnesota Univ. Technical Coll., Waseca.
G. W. Randall, and V. A. Bandel.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 39-63, 12 tab, 26 ref.

Descriptors: *Nitrogen, *Agricultural practices, *Conservation tillage, *Water pollution prevention, *Water pollution sources, Leaching, Volatilization, Denitrification, Fertilizers, Urea, Water use efficiency, Ammonium nitrate, Groundwater pollution, Nitrates.

Conservation tillage leaves significant amounts of plant residues on the soil surface which can greatly affect water intake and N loss mechanisms, e.g., volatilization, leaching, and denitrification. Volatilization losses of N from surface-applied urea-containing N fertilizers can be substantial. Moreover, for a variety of reasons the trend among producers has been to move away from anhydrous ammonia toward urea and urea-ammonium nitrate, which are often surface-applied. This paradox requires the development of better injection/incorporation techniques that allow growers to manage their N better in the future. Presently, agronomists recognize this volatilization problem and many make recommendations to guard against these losses. In some cases, higher rates of N are recommended with conservation tillage (CT) compared to conventional tillage. This could lead to increased amounts of NO3 leached toward the groundwater if the N is not taken up by the plant, volatilized, immobilized or denitrified. Under drier, non-irrigated conditions of the Great Plains, CT is generally thought to reduce NO3 losses to the groundwater because of greater water use efficiency resulting in greater N uptake and higher yield. In the more humid areas of the U.S., a consensus among agronomists was not reached as to the relationship of CT to NO3 in the groundwater. The role of CT on the fate of N in a cropping system needs to be more clearly defined with further research; especially with respect to immobilization, mineralization, and water flow characteristics. (See also W88-05759) (Lantz-PTT)
W88-05762

**OVERVIEW OF RURAL NONPOINT POLLUTION IN THE LAKE ERIE BASIN,**
Heidelberg Coll., Tiffin, OH.
For primary bibliographic entry see Field 5B.
W88-05763

**HYDROLOGIC SOIL PARAMETERS AFFECTED BY TILLAGE,**
Agricultural Research Service, Morris, MN. North Central Soil Conservation Research Center.
C. A. Onstad, and W. B. Voorhees.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 95-112, 6 fig, 3 tab, 40 ref.

Descriptors: *Soil properties, *Tillage, *Agricultural practices, *Hydrologic properties, *Soil water, Aggregates, Pore size, Soil porosity, Rainfall, Conservation tillage, Energy, Freeze-thaw cycles.

Tillage affects soil properties which in turn affect hydrologic response. Often, studies are conducted relating runoff rates and quantities of rainfall, both expressed precisely, without regard for quantitative expression of the soil characteristics. In order for trends to be extrapolated, it is not sufficient to use qualitative terms such as 'moldboard plowing' or 'no-till' to express soil conditions during the event. Instead, the soil needs to be quantified in terms of residue cover, surface roughness, structure, aggregate stability, total pore space, and pore size distribution. Tilled soil physical properties are dynamic. They are affected by type of tillage, tillage sequence, wheel traffic, and natural degradation factors. Most important, natural factors include rainfall kinetic energy, soil wetting and drying cycles, and soil freezing and thawing cycles. Included are descriptions of the major affected soil physical properties. This includes the effects of residue management zone as influenced by tillage and natural degradation. These are related to tillage characteristics and natural degradation. (See also W88-05759) (Lantz-PTT)
W88-05764

**HYDROLOGIC EFFECTS OF CONSERVATION TILLAGE AND THEIR IMPORTANCE RELATIVE TO WATER QUALITY,**
Iowa State Univ., Ames.
J. L. Baker.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 113-124, 6 tab, 33 ref.

Descriptors: *Conservation tillage, *Soil water, *Hydrologic properties, *Water quality control, Infiltration, Tillage, Rainfall, Cultivation, Water volume, Aquifers, Groundwater recharge, Path of pollutants, Fertilizers, Leaching.

Whether conservation tillage decreases or increases subsurface drainage is closely tied with the effect this tillage has on infiltration. For all storms over a longer period (such as one growing season or longer) the effect is much more apparent than for small rainstorms that occur directly after tillage. It needs to be emphasized that not just the volume, but the timing and route of infiltrating water is very important relative to chemical losses in surface runoff and subsurface drainage which may recharge aquifers or be intercepted by shallow drain tubes. The volume of drainage water is important in determining losses, but for surface-applied chemicals that are not strongly adsorbed, initial infiltration before runoff begins can be an important factor in decreasing concentrations and losses in surface runoff. Similarly for chemicals that degrade or dissipate with time after application, infiltration rates for the first few storms after application are important in determining surface runoff losses. On the other hand the infiltration that decreases surface runoff may enhance leaching losses. The route that leaching water takes through the soil profile (e.g., through macropores) relative to the location of a chemical of concern can also strongly influence leaching losses. Crop, soil, residue, and chemical management practices need to be manipulated in order to obtain the 'best' system. (See also W88-05759) (Lantz-PTT)
W88-05765

**SOIL CHEMICAL AND BIOLOGICAL PROPERTIES AS AFFECTED BY CONSERVATION TILLAGE: ENVIRONMENTAL IMPLICATIONS,**
Ohio State Univ., Wooster. Agricultural Technical Inst.
W. A. Dick, and T. C. Daniel.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 125-147, 4 fig, 7 tab, 64 ref.

Descriptors: *Soil chemistry, *Soil biology, *Conservation tillage, *Environmental effects, Tillage, Hydrogen ion concentration, Nutrients, Root zone, Soil mixing, Chemical properties, Biological properties, Fertilizers, Agricultural practices, Soil profiles.

Conservation practices have a major impact on the chemical and biological properties of soil. When compared to conventional tillage (CnT), the surface soil layer of conservation tillage (CT) fields, especially no tillage (NT), becomes enriched in hydrogen ions, plant nutrients, and biological activity. In the lower portion of the rooting zone, from approximately 5 to 10 cm depth, the opposite trend often occurs and the NT soil has lower concentrations of the chemical and biological parameters. Tillage operations, in which the soil is inverted and mixed, tends to counteract changes in chemical and biological properties. However, with CT and most noticeably NT, the growing of annual crops and additions of fertilizer produce changes in the soil profile that are noticeable in only a few years. The effect of these changes in soil chemical and biological properties must be clearly defined and understood if the impacts of tillage on the environment are to be fully comprehended. (See also W88-05759) (Lantz-PTT)
W88-05766

**EFFECT OF CONSERVATION TILLAGE ON BIOLOGICAL AND CHEMICAL SOIL CONDITIONS: REGIONAL AND TEMPORAL VARIABILITY,**
Kentucky Univ., Lexington.
M. S. Smith, and R. L. Blevins.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 149-166, 6 fig, 5 tab, 31 ref.

Descriptors: *Conservation tillage, *Soil chemistry, *Soil biology, *Environmental effects, *Temporal variation, Soil stratification, Soil properties, Evaporation, Soil type, Soil bacteria, Temperature, Soil water, Respiration.

The most widely applicable generalization of how conservation tillage effects the chemical and biological properties of soil, is that conservation tillage results in a stratification of the soil, with a relative accumulation of nutrients, acidity, organic matter and microbes near the surface. Emphasized here is that the magnitude of this effect, and the nature of other biological and chemical effects, will vary. The effects of any tillage system will depend on climate, soil type, quantity of residues produced, previous management history, time of year and time since the tillage system was initiated. It is not expected that reduced evaporation by surface residues will have the same effect on microbial activity in a poorly-drained clay and in a well-drained sand. Reduced temperatures under a no-till mulch can decrease microbial respiration in Minnesota but increase it in Nigeria. Because tillage per se is not a primary, direct determinant of biological activity, it seems that predicting tillage system effects on biological activity must be an indirect, two-step process. First, how tillage systems influence the chemical and physical environment of soil organisms must be understood, particularly temperature, moisture and substrate availability. Second, how microbes and the reactions they catalyze are effected by these environmental changes must be understood in a quantitative and dynamic way. (See also W88-05759) (Lantz-PTT)

W88-05767

**EFFECTS OF CONSERVATION TILLAGE PRACTICES ON PESTICIDE VOLATILIZATION AND DEGRADATION,**
Agricultural Research Service, Beltsville, MD.
For primary bibliographic entry see Field 5B.
W88-05768

**EFFECT OF CONSERVATION TILLAGE ON PESTICIDE DISSIPATION,**
Agricultural Research Service, Beltsville, MD.
For primary bibliographic entry see Field 5B.
W88-05769

**PROCESSES INFLUENCING PESTICIDE LOSS WITH WATER UNDER CONSERVATION TILLAGE,**
Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 5B.
W88-05770

**EFFECTS OF CONSERVATION TILLAGE ON PESTICIDE LOSS WITH WATER,**
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Center.
R. D. Wauchope.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 205-215, 1 fig, 42 ref.

Descriptors: *Conservation tillage, *Pesticides, *Path of pollutants, Agricultural practices, Herbicides, Groundwater pollution, Surface runoff, Nonpoint pollution sources, Research priorities.

Among all the concerns and issues related to conservation tillage (CT) adoption, one wants to minimize nonpoint pesticide loads to surface and groundwaters. This is not necessarily because the environmental impacts of such an increase are known to be negative. In many cases, it is simply that what, if any, of the effects are known. In general, it appears that current loadings of pesticides to surface waters in the US are not a serious problem. Thus, if CT does not increase the loadings significantly, this aspect of CT will presumably not be a problem. The current concern over pesticides in groundwater complicates things, however. Although something is known about surface water (runoff) pesticide losses from conventional cropping, groundwater losses are another dimension of the problem about which much less is known. These points can be broken down into three concerns, listed here in order of increasing difficulty. These provide a research agenda. (1) Whether CT adoption increases pesticide use; (2) How CT adoption affects the processes controlling pesticide runoff losses; and (3) Whether the increased pesticide usage in CT combines with runoff, decreasing the shunt of pesticides to groundwater. These research priorities for addressing these points are discussed here through field experiments, physical simulation, and mathematical modelling. (See also W88-05759) (Lantz-PTT)
W88-05771

**EFFECT OF CONSERVATION TILLAGE ON FATE AND TRANSPORT OF NITROGEN,**
North Carolina State Univ., Raleigh.
J. W. Gilliam, and G. D. Hoyt.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 217-240, 5 tab, 69 ref.

Descriptors: *Nitrogen, *Path of pollutants, *Conservation tillage, *Fate of pollutants, Fertilizers, Agricultural practices, Tillage, Volatilization, Organic compounds, Surface runoff, Leaching, Root zone.

A comparison between the fate of nitrogen in conservation tillage or no-till (NT) to the fate of N in conventional tillage (CT) is conducted. Volatilization of N as ammonia is a much larger problem with surface applied urea-based fertilizers in NT than in CT. Denitrification losses also tend to be greater under NT as compared to CT largely because of the increased moisture in the NT fields. There has been a large amount of work quantifying the amount of N which is either mineralized or immobilized under conservation tillage management. It is clear that conversion from CT to any form of conservation tillage will usually result in an increase in organic N present in the soil Most researchers have found that these increases will continue for many years. However, it has also been shown that conversion of grassland to conservation tillage will generally result in a decrease in soil organic N. The data on loss of N by surface runoff should be sufficient to convince anyone that NT results in less total N loss via this path as compared to CT. The reduction occurs as a result of a decrease in sediment-associated organic N. Most environmental problems resulting from use of N fertilizer in agricultural production are caused by N which is leached below the rooting zone. Thus far, this study concludes that: (1) NT increased N loss by volatilization but this loss is likely to be overcome by better fertilizer application methods; (2) denitrification removes slightly more N from NT; (3) immobilization will increase the amount of N present in the soil as organic N but the system will reach a new steady state level of N so this will not be a continual sink for N; (4) N harvested by the crop is not greatly different; and (5) there is less loss of N by surface runoff. (See also W88-05759) (Lantz-PTT)
W88-05772

**EFFECT OF CONSERVATION TILLAGE ON PROCESSES AFFECTING NITROGEN MANAGEMENT,**
Agricultural Research Service, Lincoln, NE.
J. S. Schepers.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 241-250, 2 fig, 1 tab, 18 ref.

Descriptors: *Conservation tillage, *Nitrogen, *Water quality management, Soil water, Percolation, Leaching, Root zone, Organic matter, Soil properties, Agricultural practices, Pore size, Interstitial water, Fertilizers, Ammonia, Nitrates, Hydrogen ion concentration.

The physical process of nitrate leaching requires sufficient soil water for percolation and availability of nitrate ions in close proximity to the moving water. Soils with little structure transmit percolating water very rapidly and readily contribute any available nitrate to the solution. Finer textured soils tend to promote better structure, especially in the root zone where organic matter is more prevalent, and reduce the percolation rate. Soil water content fluctuations are usually greater in the root zone than in the vadose zone because of plant growth and evaporation. Therefore, climatic factors and processes within the root zone are the most likely to influence groundwater quality. Many processes contribute to the nitrate leaching potential of a soil with associated tillage systems. Simply examining mineralization, nitrification and denitrification processes may not adequately address the complexities of tillage systems and therefore generalities should be carefully examined for unique features of the soil, location and climate. Any tillage operation that changes soil bulk density in turn modifies soil pore size distribution. In terms of N cycling, these changes could stimulate aerobic processes at the expense of the anaerobic processes, or vice-versa. Since each soil type and cropping system responds differently to tillage, what may be desirable tillage system in one location may be complete failure in another. The dynamics of soil biological processes are known to be a function of temperature, water status, aeration, pH and substrate availability. All of these soil properties can be influenced by tillage and, for that reason, each must be considered when evaluating a tillage system. Fortunately, N mineralization is insensitive to pH between values of 6.2 and 9.0; however, nitrification only proceeds at its maximum rate between pH 7.0 and 7.4. For this reason, ammonium-N may temporarily dominate the inorganic N pool of acidic surface soils, especially under no-tillage where surface applied N and mineralization of surface residues have acidified the soil. Ammonium-N is less susceptible to leaching than nitrate-N, and hydroponic studies with wheat and field studies with corn indicate plants prefer a combination of nitrate- and ammonium-N sources, which may be a positive attribute of no-tillage systems. (See also W88-05759) (Lantz-PTT)
W88-05773

**MANURE MANAGEMENT WITH CONSERVATION TILLAGE,**
Cornell Univ., Ithaca, NY.
M. F. Walter, T. L. Richard, P. D. Robillard, and R. Muck.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 253-270, 5 fig, 3 tab, 14 ref.

Descriptors: *Manure, *Conservation tillage, *Environmental effects, *Agricultural practices, Fertilizers, Nitrogen, Surface runoff, Nutrients, Groundwater quality, Groundwater pollution, Land application.

Many of the issues related to protecting environmental quality become even more complex when resources other than just soil and water are considered. Two of these are labor and energy, and these are tied very closely to a third, livestock manure. Conservation tillage maintains crop residue at the surface as a means to reduce erosion and protect soil resources. An important goal in land application of manure is to incorporate the manure in the soil to conserve the manurial nutrients and reduce surface water contamination. Nearly every recommendation for surface application of manure on cropland suggests incorporating the manure as soon as possible following land spreading. It would appear that the attempt to maintain residues on the surface through use of conservation tillage might be in conflict with that of incorporating manure. Much of the discussion in this paper deals with dairy farms. In general, the observations are applicable to other types of livestock farming, but it is known that each situation is unique. Differences in solids and nutrient content among manures from different livestock will affect handling, storage, and application technologies, and some of the comments about nutrient management and water quality protection will not apply in all cases. However, in general, experience with tillage-manure systems leads to the following six summary statements: (1) Conservation tillage and manure management are compatible; (2) Effects of manurial nitrogen on crop yields are the same for both moldboard and chisel plowing; (3) Losses of manurial nutrients in surface runoff are greatly reduced by a little incorporation; (4) Manurial residue can significantly reduce runoff from cropland where residue has been removed; (5) Management costs of utilizing manurial nutrients as perceived by the farmer can be extremely high; and (6) Because manure is not generally utilized as a fertilizer source, there is a potential groundwater problem with any tillage system. (See also W88-05759) (Lantz-PTT)
W88-05774

**ASSESSMENT OF GREAT LAKES TILLAGE PRACTICES AND THEIR POTENTIAL IMPACT ON WATER QUALITY,**
Ohio State Univ., Columbus.
For primary bibliographic entry see Field 5C.
W88-05775

**ERODING SOILS: THE OFF-FARM IMPACTS,**
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 2J.
W88-05845

## 4D. Watershed Protection

**DISTRIBUTED DYNAMIC WATERSHED MODEL,**
Texas A and M Univ., College Station. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W88-05207

RUNOFF LOSSES FROM EIGHT WATERSHEDS AS INFLUENCED BY SOIL COVER CONDITION AND MANAGEMENT SYSTEMS AT EL RENO, OKLAHOMA,
Oklahoma State Univ., Stillwater. Graduate Coll.
For primary bibliographic entry see Field 5B.
W88-05210

LAKE SEDIMENTATION REDUCTION TECHNIQUES,
Illinois State Water Survey Div., Champaign.
K. P. Singh.
Public Works PUWOAH, Vol. 118, No. 9, p 99-102, September 1987. 2 fig, 18 ref.

Descriptors: *Sedimentation, *Sediment control, *Erosion control, *Lakes, Sediment transport, Lake sediments, Density currents, Reservoir operation, Reservoir trap efficiency, Deltas, Nutrients, Water quality, Watershed management, Dams.

Lake sedimentation reduction dates to the sixteenth century in Spain, where deposits were removed by scouring with flood flows. Factors which affect erosion, sediment transport, and lake sedimentation are watershed erosion control, reservoir trap efficiency, water residence time, density currents from the difference between incoming water and stored water, delta formation, capacity-inflow ratio, streambed degradation downstream, and water quality. Essential components of a lake sedimentation reduction plan are (1) reduction in input of the relatively coarse sediment fraction, (2) reduction in entrapment of relatively fine and some coarse sediment fractions entering the lake, and (3) lake operation and management to maximize the efficiency of the first two components and to improve the lake water quality. Coarse sediment may be reduced by a small check dam a few miles upstream of the reservoir or pipelines to discharge the bulk of the sediment downstream of the dam. Reduction of reservoir trap efficiency may be accomplished by incorporating undersluices and sluiceways into the impounding structure. Reservoir operation can be planned to further reduce sedimentation. This requires modeling of the underlying physical processes. (Cassar-PTT)
W88-05353

IMPROVEMENTS IN WATERSHED MANAGEMENT ENHANCE CASH FLOW,
Washington Suburban Sanitary Commission, Brookeville, MD.
M. J. Grear.
WATER/Engineering and Management WENMD2, Vol. 135, No. 2, p 33-35, February 1988.

Descriptors: *Watershed management, *Economic aspects, *Profit, *Patuxent watershed, *Multipurpose reservoirs, *Hydroelectric power, *Forest watersheds, Costs, Maryland, Pine trees, Paulownia trees.

Recently the Patuxent Watershed staff in Maryland examined how resources might be used effectively to continue to provide costly recreational amenities while still accomplishing the primary mission of providing a reliable source for a water supply of top quality and adequate quantity. Over 30 ideas and some surprises came to light as a result of this detailed review of existing operations. Low head hydroelectric power was one of the approaches considered in the recent review. The Washington Suburban Sanitary Commission also continues to follow a policy of sound management of land and forestry resources to provide maximum watershed, water quality and reservoir storage capacity protection while also providing valuable by-products. One idea implemented to make more productive use of underutilized open acreage on the Patuxent Watershed property is the crop production of Paulownia trees. (VerNooy-PTT)
W88-05431

IMPLEMENTING DUAL-PURPOSE STORMWATER DETENTION PROGRAMS,
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
W. Whipple, R. Kropp, and S. Burke.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 6, p 779-792, November, 1987. 1 fig, 19 ref.

Descriptors: *Flood-control storage, *Detention reservoirs, *Storm runoff, *Water quality management, *Watershed management, *Settling basins, Flood control, Reservoirs, Basins, Sedimentation, Erosion control, Runoff, Urban runoff, Political constraints, Legal aspects, Administrative decisions, Policy making, Federal jurisdiction, State jurisdiction, Legislation, Planning.

Stormwater management has been mainly directed to requiring developers to take steps to reduce flood damages due to increased runoff caused by their developments. The principal means employed has been conventional detention basins. More recently, it has been recognized that runoff pollution from development is detrimental to environmental quality downstream. A dual-purpose detention basin is described. This system can settle out pollutants in particulate form with little increase in cost and an additional flood control benefit downstream. For best results, a basin-wide planning approach is needed, which usually results in including master detention basins in the plan. Various institutional considerations are important, including coordination with the non-point source pollution control program expected to be authorized under the Clean Water Act. New Jersey's Stormwater Management Program is discussed to illustrate these points. (Doria-PTT)
W88-05614

ELEMENTS OF A COMPREHENSIVE STORMWATER MANAGEMENT PROGRAM,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
M. E. Hawley, and R. H. McCuen.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 6, p 793-809, November, 1987. 7 ref, 1 append.

Descriptors: *Water quality management, *Watershed management, *Storm runoff, *Political aspects, *Policy making, *Planning, Administrative decisions, Legal aspects, Regulations, State jurisdiction, Federal jurisdiction, Legislation, Permits, Zoning, Land management, Design criteria, Maintenance, Performance evaluation, Inspection.

Programs for stormwater management (SWM) have been promulgated by a variety of state, regional, and local government agencies. Existing SWM programs exhibit significant variation in objectives, requirements, and the division of responsibilities among public agencies and private parties. Some of these programs have been more successful than others. In some cases, this lack of success is partly attributable to deficiencies in program content. A list of regulatory elements that should be considered for inclusion in a comprehensive SWM program is presented, compiled by examining and analyzing the regulations of many existing programs. The purpose of each element is discussed, as are the relationships among the various elements. This material should be useful to governments both in developing appropriate regulatory programs for SWM and in revising existing programs. (Author's abstract)
W88-05615

# 5. WATER QUALITY MANAGEMENT AND PROTECTION

## 5A. Identification Of Pollutants

OCCURRENCE OF BACTERIAL RESISTANCE TO ARSENITE, COPPER, AND SELENITE IN ADVERSE HABITATS,
Wright State Univ., Dayton, OH. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5C.
W88-05110

CHLORINATED PESTICIDE RESIDUES IN SEDIMENTS FROM THE ARABIAN SEA ALONG THE CENTRAL WEST COAST OF INDIA,
National Inst. of Oceanography, Panaji (India).
For primary bibliographic entry see Field 5B.
W88-05118

VANADIUM CONTAMINATION MONITORED BY AN ARCTIC BIVALVE, CYRTODARIA KURRIANA,
McMaster Univ., Hamilton (Ontario). Dept. of Geology.
B. P. Bourgoin, and M. J. Risk.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 1063-1068, 1987. 2 fig, 1 tab, 13 ref.

Descriptors: *Pollutant identification, *Vanadium, *Bivalves, *Arctic, *Sediments, *Bioassay, Heavy metals, Speciation, Tissue analysis, Clams, Monitoring, Extraction.

The Arctic Propeller clam, Cyrtodaria kurriana (Dunker), is the most common filter feeding bivalve in Tuktoyaktuk Harbour and is a major component in the trophic chain. The utility of this bivalve as a monitor for vanadium contamination in the Arctic environment was investigated. In July 1985, sediment and Cyrtodaria kurriana samples were collected at 8 stations in Tuktoyaktuk Harbor and 1 control station in McKinley Bay, on the Tuktoyaktuk Peninsula. Additional sediment samples were collected at 7 other stations in Tuktoyaktuk Harbor. The total vanadium content in the sediments fell within background levels ranging from 114 to 180 microgram/g. The McKinley Bay control sample contained 153 microgram/g vanadium, in the range recorded for Tuktoyaktuk sediments. The tissue analyses, however, revealed that Cyrtodaria kurriana specimens collected from Tuktoyaktuk Harbor contained about 5 times more vanadium than those obtained from McKinley Bay. The acid extraction further showed that 10 times as much vanadium was extracted from the Tuktoyaktuk Harbor sediments than the McKinley Bay sediments. This study suggests that Cyrtodaria kurriana can serve as a useful environmental monitor for vanadium contamination and also illustrates the importance of evaluating the speciation of particulate trace metals. (Alexander-PTT)
W88-05120

ORGANOCHLORINE AND METAL POLLUTION IN AQUATIC ORGANISMS SAMPLED IN THE DONANA NATIONAL PARK DURING THE PERIOD 1983-1986,
Consejo Superior de Investigaciones Cientificas, Madrid (Spain). Inst. de Quimica Organica General.
For primary bibliographic entry see Field 5B.
W88-05122

METHODS FOR RECOVERING POLIOVIRUS AND ROTAVIRUS FROM OYSTERS,
Health and Welfare Canada, Ottawa (Ontario). Health Protection Branch.
J. I. Speirs, R. D. Pontefract, and J. Harwig.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 11, p 2666-2670, November 1987. 6 tab, 24 ref.

Descriptors: *Pollutant identification, *Viruses, *Oysters, *Poliovirus, *Rotavirus, Shellfish, Aquatic animals, Flocculation, Wastewater pollution, Ultrafiltration, Sample preparation.

Several methods for detecting polioviruses and rotaviruses in oysters were assessed. Elution-precipitation using Catfloc for clarification and skim milk for subsequent flocculation resulted in average of recoveries of 90% of poliovirus type 1 and 81% of rotavirus SA-11. Adding an acid precipitation step before the elution-precipitation produced recoveries of 79% and 37%, respectively. When elution supernatants were concentrated by ultracentrifugation, recoveries were 78% of poliovirus and 47% of rotavirus. Concentration by two ultrafiltration processes yielded recoveries of 75-76%

poliovirus and 16-48% rotavirus. However, the ultracentrifugation and ultrafiltration procedures required longer time and produced concentrates which were more toxic to the cell cultures. (Cassar-PTT)
W88-05194

**GROWTH DETERMINATIONS FOR UNATTACHED BACTERIA IN A CONTAMINATED AQUIFER,**
Geological Survey, Menlo Park, CA.
R. W. Harvey, and L. H. George.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 11, p 2992-2996, November 1987. 3 fig, 1 tab, 21 ref.

Descriptors: *Pollutant identification, *Fate of pollutants, *Water pollution sources, *Bacteria, *Groundwater pollution, *Aquifers, *Growth rates, Wastewater pollution, Frequency of dividing cells method, Tritiated-thymidine uptake method, Bacterial analysis.

Growth rates of unattached bacteria in groundwater contaminated with treated sewage and collected at various distances from the source of contamination were estimated by using frequency of dividing cells and tritiated-thymidine uptake and compared with growth rates obtained with unsupplemented, closed-bottle incubations. Estimates of bacterial generation times ((ln 2)/u) along a 3-km-long transect in oxygen-depleted (0.1 to 0.7 mg of dissolved oxygen per liter) groundwater ranged from 16 hours at 0.26 km downgradient from an on-land, treated-sewage outfall to 139 hours at 1.6 km and correlated with bacterial abundance. Partitioning of assimilated thymidine into nucleic acid generally decreased with distance from the contaminant source, and one population in heavily contaminated groundwater assimilated little thymidine during a 20-hour incubation. Several assumptions commonly made when frequency of dividing cells and tritiated-thymidine uptake are used were not applicable to the groundwater samples. (Author's abstract)
W88-05196

**DEVELOPMENT AND EVALUATION OF ANALYTICAL PROCEDURES FOR BROAD SPECTRUM ANALYSIS OF SYNTHETIC ORGANIC CHEMICALS IN SOURCE AND FINISHED DRINKING WATERS,**
North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering.
G. S. Durell, R. F. Christman, and A. M. Dietrich.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-132766/AS. Price codes: A07 in paper copy; A01 in microfiche. North Carolina Water Resources Research Institute, Raleigh, Completion Report No. 234, August 1987. 134 p, 32 fig, 27 tab, 98 ref.

Descriptors: *Water analysis, *Chemical analysis, *Organic compounds, *Pollutant identification, *Organic wastes, *Analytical techniques, Natural waters, Laboratory equipment, Synthetic organic chemicals, Organic chemicals, Separation analysis.

Based on the scientific literature, continuous liquid-liquid extraction (CLLE) and closed loop stripping analysis (CLSA) were chosen for development and evaluation as the most appropriate extraction and concentration procedures for broad spectrum analysis of synthetic organic chemicals (SOCs) in natural waters. These procedures complemented each other better than any other combination of methods available. A set of 16 SOC standards was selected which would be representative of the wide range of SOCs which are encountered as pollutants in natural waters. Method optimization experiments were carried out by determining the percent recoveries of these representative SOCs under a variety of analytical conditions. Using the optimized analytical conditions, the CLLE and CLSA procedures were applied to natural waters so that water matrix effects could be studied and broad spectrum SOC analysis, identification, and quantification performed. A final evaluation of the developed methods was carried out by comparing results from four water samples, which were analyzed by the CLLE and CLSA methods, to results obtained at a qualified laboratory using the currently recommended EPA methods. The developed methods were found to be powerful for the analysis of a broad range of SOCs in natural waters. The CLLE/CLSA combination of procedures was applicable to a wider range of SOCs and had greater sensitivity than currently recommended EPA methods. (Lambert-UNC,WRRI)
W88-05223

**LASER FLUORESCENCE/FIBER OPTIC MONITORING OF GROUNDWATER CONTAMINANT BIODEGRADATION,**
Tufts Univ., Medford, MA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W88-05233

**EEL (ANGUILLA ANGUILLA L.) AS A BIOINDICATOR OF METAL POLLUTION: FACTORS LIMITING ITS USE,**
Nantes Univ. (France). Centre de Dosage des Elements Traces.
C. Amiard-Triquet, J. C. Amiard, A. C. Andersen, P. Elie, and C. Metayer.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1229-1232, 1987. 3 fig, 1 tab, 11 ref.

Descriptors: *Bioindicators, *Eel, *Metals, *Pollutant identification, Indicators, Fish, Bioaccumulation, Copper, Zinc, Cadmium, Environmental quality, Estuaries, Lead, Loire estuary, France.

Because of its worldwide distribution, abundance, size, long life span, and euryhalinity, the eel Anguilla anguilla was considered as a metal pollution bioindicator. Euryhalinity, which is more marked than in all other bioindicators, allows the comparison of the contamination levels of marine and estuarine areas as well as river basins, according to their degree and pattern of industrialization. The general stress tolerance of the eel was determined previously, but the larval stages are generally more susceptible than adults, and elvers live in coastal and estuarine areas which are particularly risky since they are among the most heavily polluted. Since eels are also important to fisheries, investigations were conducted to determine if the tolerance is accompanied by a high metal bioaccumulation which would constitute a threat to consumer health. The elvers were at least partially able to regulate their whole body levels of copper and zinc; therefore, they are not useful bioindicators for these metals. Internal cadmium concentration reflected the environmental level, although the mathematical relationship must still be established in the case of chronic contamination. In the Loire estuary, the young stages exhibited the highest cadmium concentrations, but lead bioaccumulation was limited in elvers prior to the pigmentary stage VI sub A3; bioconcentration in older specimens must be investigated. (Wood-PTT)
W88-05258

**MONITORING OF MERCURY AND CADMIUM IN COASTAL AREAS, USING AQUATIC ORGANISMS AND SEDIMENT,**
Vandkvalitetsinstitutet, Hoersholm (Denmark).
J. E. Lyngby, and H. Brix.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1239-1241, 1987.

Descriptors: *Bioindicators, *Pollutant identification, *Heavy metals, Mytilus, *Algae, *Sediments, *Coastal waters, Indicators, Mussels, Aquatic life, Monitoring, Denmark, Mercury, Cadmium, Pollutants.

Heavy metal pollution in the coastal waters of Denmark was investigated and the reliability of the brown algae Zostera marina, the mussel Mytilus edulis and sediment as indicators of metal pollution in shallow coastal areas was compared. Zostera, Mytilus and sediment were sampled at 75 sites in the Limfjord and at Laso, Denmark, during June 1972. Because of the elevated levels of mercury, lead, and copper reported at the Nissum Broad and at the city of Aalborg, a large proportion of the samples were taken in these areas. Mercury and cadmium concentrations were significantly elevated in the western part of the Nissum Broad and in Veno Bay, respectively. The use of Z. marina for monitoring heavy metals provided results comparable to those obtained by Mytilus and sediment. The form of the metal, and physiological and environmental factors must also be considered in the interpretation of the collected data. (Wood-PTT)
W88-05261

**BIOLOGICAL ASPECTS IN THE EVALUATION OF TERTIARY LAGOONS AND EFFICIENCY IN THE REMOVAL OF ORGANIC POLLUTANTS,**
SITEL, Triunfo (Brazil).
E. M. P. Goettems, R. L. Teixeira, and L. R. Malabarba.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1259-1261, 1987. 2 fig, 3 ref.

Descriptors: *Bioindicators, *Fish, *Pollutant identification, *Wastewater lagoons, *Wastewater treatment efficiency, *Tertiary wastewater treatment, Wastewater treatment, Toxicity, Fish physiology, Industrial wastes, Oil wastes, Brazil, Effluents, Indicators, Monitoring, Heavy metals.

The wastewater treatment plant handling the total effluents from the petrochemical complex near Porto Alegre, Brazil, uses a series of eight interconnected lagoons inhabited by several species of fish for its tertiary treatment. The fish, especially Astyanax bimaculatus which was the most abundant and appeared in all eight lagoons and the control area, were monitored as bioindicators of environmental conditions in the lagoons. Malformation histological characteristics (viscera and muscles), incorporated heavy metals, and chemical mutagenic effects were analyzed. The rate of malformations of A. bimaculatus was high in the two lagoons which receive the effluent first (average of 50.2%), while the malformation rate decreased to 2.0% in the fourth through eighth lagoons, indicating that the wastewater treatment system is effectively removing the chemical substances causing the malformations. The malformation rate was also inversely proportional to the hydraulic detention time of the effluent in the tertiary system. The accumulation of toxic substances that may be responsible for mutagenic effects was investigated. (Wood-PTT)
W88-05266

**INTERCLONAL VARIABILITY TO PSP TOXICITY IN THE DINOFLAGELLATE GONYAULAX EXCAVATA, A NEW BIOASSAY SYSTEM (VARIABILIDAD INTERCLONAL PARA TOXICIDAD PSP EN EL DINOFLAGELADO GONYAULAX EXCAVATA, UN NUEVO SISTEMA DE BIOENSAYO).**
Hospital Materno-Infantil 'Teresa Herrera', La Coruna (Spain).
Boletin del Instituto Espanol de Oceanografia, Vol. 3, No. 3, p 55-60, December 1986. 1 fig, 1 tab, 18 ref. CAI-CYT Grant 2409/83.

Descriptors: *Toxicity, *Bioassay, *Pollutant identification, *Dinoflagellates, Mollusks, Gonyaulax, Assay, Growth rates, La Coruna Bay, Spain, Monitoring, Water pollution, Pollutants.

A new PSP toxicity bioassay was developed based on growth rate inhibition in DON Chinese hamster cell cultures. This assay reports a precise measure of toxicity effects. Interclonal variability to toxicity was detected in a natural population of G. excavata dinoflagellate from La Coruna Bay. The implications of this feature in toxicity monitoring programs development are discussed. (Author's abstract)
W88-05289

**ECOTOXICOLOGICAL EFFECT INDICES: A RAPIDLY EVOLVING SYSTEM,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
J. Cairns, and J. R. Pratt.
Water Science and Technology WSTED4, Vol. 19, No. 11, p 1-12, 1987. 1 fig, 3 tab, 36 ref.

Descriptors: *Reviews, *Water pollution effects, *Ecosystems, *Environmental effects, *Bioindicators, Environmental protection, Environmental policy, Indicators, Toxicity, Ecology.

The history and future of ecotoxicological effect indices are reviewed and evaluated. Ecotoxicology has evolved from a modest number of single species, acute toxicity tests to an integrated system of hazard evaluation for predicting adverse effects of chemicals and complex mixtures on environmental health. Microcosms and mesocosms can be constructed and experiments conducted in a cost-effective manner, and several end points can be measured in complex systems using the standard dose-response paradigm. To be effective hazard evaluation tools, microcosms and mesocosms must include ecologically meaningful processes and must be useful in making decisions regarding environmental safety and harm. Despite hopes that a few sensitive species might be used to make decisions quickly on environmental effects, ecological health will be maintained only when scientists and regulators come to grips with the problem of protecting ecologically important processes as well as sensitive species. This will mean developing tests with increasing environmental realism in which environmentally realistic concentrations of chemicals can be tested without resorting to the use of safety factors or extrapolation from limited data bases. Developing such tests does not mean skyrocketing costs for screening chemicals and effluents, but suggests that regulators and toxicologists will need to deal with new information and learn new skills rather than relying on historically pleasing but ecologically deficient testing programs. (Author's abstract)
W88-05292

**VARIABILITY OF TEST SYSTEMS USED TO ASSESS ECOLOGICAL EFFECTS OF CHEMICALS,**
Construction Engineering Research Lab. (Army), Champaign, IL.
D. J. Schaeffer, D. K. Cox, and R. A. Deem.
Water Science and Technology WSTED4, Vol. 19, No. 11, p 39-45, 1987. 4 tab, 5 ref.

Descriptors: *Toxicity, *Water pollution effects, *Ecosystems, *Bioassays, *Statistical analysis, Mussels, Mollusks, Insects, Aquatic insects, Oysters, Assay, Ecology, Distribution, Seasonal distribution, Life cycles, Fish.

Biological test systems are widely used to assay toxicity in the laboratory and the field. The variability of test systems is discussed, and two criteria are suggested for distinguishing among test systems based on their variability: (1) a low coeffecient of variability and (2) independence between the mean and the coefficient of variation. Four recommendations are made. First, test systems with $v < 20\%$ should be used when available. Second, temporal variability must be explicitly considered in system selection, since a test system showing seasonal variability can be a sensitive indicator of effect in some situations or totally confounding in others. Third, it must be determined whether changes in the mean are proportionate to the exposure, attain a limit that renders it simply a 'yes-no' test, or vary randomly. The first is most desirable, while the last probably renders the test system unusable for the intended purpose. Finally, it must be determined whether SD the standard diviation remains constant as the mean increases, rapidly attains a limiting value, increases with the mean, or varies randomly. Systems falling into the first two groups are preferred. (Doria-PTT)
W88-05295

**SELECTION OF TEST SYSTEMS FOR ECOLOGICAL ANALYSIS,**
Illinois Univ., Urbana. Dept. of Civil Engineering.
E. E. Herricks, and D. J. Schaeffer.
Water Science and Technology WSTED4, Vol. 19, No. 11, p 47-54, 1987. 3 tab, 11 ref.

Descriptors: *Monitoring, *Bioassays, *Environmental policy, *Ecosystems, *Toxicity, Assay, Water pollution effects, Population dynamics, Nutrients, Cycling nutrients, Physiology, Behavior, Epidemiology, Ecology, Chemical composition.

A methodology was developed for the selection of test systems used to assess the ecological effects of chemicals. The process includes the recognition of ecosystem critical factors, identification of potential measures for these factors, and selection of appropriate metrics for experimentation or assessment. A decision tree that leads to two methods for test systems is proposed. The use of the desision tree is most effective when sufficient data exists to support decision tree analysis and identification of important issues on the site to be tested. Two general approaches to test system selection are possible: (1) the focus is on characterization of the chemical being released and its environmental fate; and (2) the bioassessment approach, which requires the existence of a reference, (uncontaminated) area available for comparison or experimental manipulation. (Doria-PTT)
W88-05296

**DEVELOPING AUTOMATED MULTISPECIES BIOSENSING FOR CONTAMINANT DETECTION,**
Tennessee Technological Univ., Cookeville. Center for the Management, Utilization and Protection of Water Resources.
E. L. Morgan, R. C. Young, C. N. Crane, and B. J. Armigate.
Water Science and Technology WSTED4, Vol. 19, No. 11, p 73-84, 1987. 3 fig, 36 ref.

Descriptors: *Monitoring, *Automation, *Bioindicators, *Pollutant identification, *Toxicity, *Water quality control, Assay, Bioassay, Aquatic life, Aquatic animals, Aquatic insects, Ecosystems, Protection, Environmental protection, Computers, Quality control, Mussels, Mollusks, Mayflies, Caddisflies.

A computer-assisted multiple species biosensing system was developed for water quality monitoring. In addition to fish, emphasis was placed on detecting species-specific bioelectric potentials produced by unrestrained mussels, burrowing mayfly nymphs (Hexagenia spp.), and case-building caddisfly larvae. A specially designed differential amplifier was used for measuring bioelectric potentials induced from various activities of test subjects. Selected responses were detected as discrete analog signals, digitized, and filed on computer disk. A management program provided various means for data gathering, filing, and retrieval. Two pilot biomonitors were developed, each consisting of an instrumentation minicomputer with up to 12 biosensor input channels and various output peripherals including hardcopy and modem. These systems, combined with an IBM-XT personal computer-based biomonitor interfaced to 24 multichannel biosensor and physical parameter inputs, complete the network. Results show that bioelectric signals generated from a variety of freshwater species may be easily monitored in a similar manner and viewed as representative measures in community toxicity testing. (Doria-PTT)
W88-05298

**BIOASSAYS WITH AQUATIC ORGANISMS: TOXICITY OF WATER AND SEDIMENT FROM CUBATAO RIVER BASIN,**
Companhia de Tecnologia de Saneamento Ambiental, Sao Paulo (Brazil).
For primary bibliographic entry see Field 5C.
W88-05300

**USE OF THE BENTHIC COMMUNITY AS A WATER QUALITY INDICATOR IN THE CUBATAO RIVER BASIN,**
Companhia de Tecnologia de Saneamento Ambiental, Sao Paulo (Brazil).
For primary bibliographic entry see Field 5C.
W88-05301

**AERIAL SPRAY OF MOSQUITO ADULTICIDES IN A SALT MARSH ENVIRONMENT,**
Harbor Branch Foundation, Inc., Fort Pierce, FL.
For primary bibliographic entry see Field 5B.
W88-05302

**VARIABILITY IN THE FREQUENCY OF SISTER-CHROMATID EXCHANGE IN LARVAE OF MYTILUS EDULIS: IMPLICATIONS FOR FIELD MONITORING,**
Lawrence Livermore National Lab., CA. Environmental Sciences Div.
For primary bibliographic entry see Field 5C.
W88-05305

**GAS CHROMATOGRAPHIC DETERMINATION OF SODIUM MONOFLUOROACETATE IN WATER BY DERIVATIZATION WITH DICYCLOHEXYLCARBODIIMIDE,**
Nagano Research Inst. for Health and Pollution (Japan).
H. Ozawa, and T. Tsukioka.
Analytical Chemistry ANCHAM, Vol. 59, No. 24, p 2914-2917, December 15, 1987. 6 fig, 1 tab, 14 ref.

Descriptors: *Sample preparation, *Chemical analysis, *Water analysis, *Sodium monofluoroacetate, *Pollutant identification, *Pesticides, *Dicyclohexylcarbodiimide, *Electron capture gas chromatography, Chromatography, Trace levels, Gas chromatography, Reagents, Chemical reactions, Silica, Rodenticides.

A method is described for determining trace amounts of sodium monofluoroacetate (MFA-Na) a rodenticide for the control of field mice, in water. MFA-Na was converted to the dichloroanilide derivative in a water sample acidified with hydrochloric acid by using N,N'-dicyclohexylcarbodiimide (DCC) and 2,4-dichloroaniline (DCA), and the derivative was extracted from the sample water and cleaned up by silica gel column chromatography. The derivative was quantified by gas chromatography with electron capture detection (GC-ECD). The limit of detection was 0.0006 micrograms/ml, with a 50-ml water sample. The recoveries from environmental waters spiked at concentrations of 0.005-0.01 micrograms/ml were 93-97% < than 4% relative standard deviation. (Author's abstract)
W88-05306

**INFLUENCE OF SORPTION PROCESSES ON ALUMINUM DETERMINATIONS IN ACIDIC WATERS,**
University Coll. of Swansea (Wales). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W88-05315

**SEATTLE'S EXPERIENCE WITH DISTRIBUTION SYSTEM SAMPLING,**
Seattle Dept. of Water, WA.
For primary bibliographic entry see Field 5F.
W88-05324

**COMPARING THREE SAMPLING DESIGNS FOR MONITORING COLIFORMS IN SMALL COMMUNITY WATER SYSTEMS,**
Dartmouth Medical School, Hanover, NH.
For primary bibliographic entry see Field 5F.
W88-05327

**FREQUENCY-OF-OCCURRENCE MONITORING FOR COLIFORM BACTERIA IN SMALL WATER SYSTEMS,**
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
W. O. Pipes, K. Mueller, M. Troy, and H. A. Minnigh.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 11, p 59-63, November 1987. 4 tab, 9 ref. EPA Grant CR-810713 .

Descriptors: *Pollutant identification, *Water treatment, *Data acquisition, *Monitoring, *Coliforms, *Bacterial analysis, Sampling, Clark presence-absence test, Water analysis, Membrane filters, Microbiological studies.

The effectiveness of Clark's presence-absence (P-A) test was compared with that of the membrane

filter (MF) technique during an evaluation of the frequency-of-occurrence approach to microbiological monitoring of water systems. Results showed no significant difference between the fractions that were positive by the two methods. Major changes in the microbiological quality of the water were detected with equal frequency by the P-A test and the MF method and were detected more readily by the frequency-of-occurrence parameter than by the average MF coliform count. (Author's abstract)
W88-05329

**SPECTROPHOTOMETRIC DETERMINATION OF TOTAL CYANIDE IN WASTE WATERS IN A FLOW-INJECTION SYSTEM WITH GAS-DIFFUSION SEPARATION AND PRECONCENTRATION,**
Academia Sinica, Shenyang (China). Inst. of Forestry and Soil Science.
Z. Zhu, and Z. Fang.
Analytica Chimica Acta ACACAM, Vol. 198, p 25-36, July 15, 1987. 7 fig, 2 tab, 17 ref.

Descriptors: *Pollutant identification, *Wastewater analysis, *Cyanide, *Spectrophotometry, Flow-injection, Cobalt, Gas-diffusion separator.

An automated flow-injection system with gas-diffusion separation and preconcentration and spectrophotometric detection is described for the determination of total cyanide in waste waters. An unstable red intermediate product of the reaction of cyanide with isonicotinic acid and 3-methyl-1-phenyl-pyrazolin-5-one is used instead of the conventional blue final product to improve the efficiency. A novel combination of a gas-diffusion separator with the sampling valve enables efficient on-line separation, preconcentration and sampling of cyanide. The sampling frequency is 40 per hour, and the detection limit is 0.006 microgram/ml when a 2-ml sample is taken and a preconcentration factor of 3.5 is achieved. The relative standard deviation is 1.4% (n=22) at the 0.5 microgram/ml level. Results obtained with the proposed method are in good agreement with the standard manual spectrophotometric method. Interference studies show that in the presence of 1,10-phenanthroline, most potential interferents present in appreciable amounts do not interfere, but the interference form cobalt is not overcome in this system. (Author's abstract)
W88-05357

**INDIRECT DETERMINATION OF FLUORIDE IN WATERS WITH LANTHANUM ALIZARIN COMPLEXONE AND INDUCTIVELY COUPLED PLASMA EMISSION SPECTROMETRY,**
National Research Inst. for Pollution and Resources, Yatabe (Japan).
For primary bibliographic entry see Field 7B.
W88-05358

**ATOMIC ABSORPTION SPECTROMETRIC DETERMINATION OF TRACE COPPER IN WATER BY SORPTION ON AN ION-EXCHANGE RESIN AND DIRECT ATOMIZATION OF THE RESIN,**
Rikkyo Univ., Tokyo (Japan). Dept. of Chemistry.
T. Takada, and T. Koide.
Analytica Chimica Acta ACACAM, Vol. 198, p 303-308, July 15, 1987. 4 fig, 2 tab, 6 ref.

Descriptors: *Pollutant identification, *Water analysis, *Copper, *Ion exchange, *Spectrometry, Resins, Trace metals, Metals, Heavy metals, Atomic absorption spectroscopy.

Traces of copper were adsorbed on a strong acid-cation exchange resin, Amberlite IR-120B. Mean particle size of the resin beads was 0.85 mm. The procedure involved placing ten resin beads in a beaker containing 50 ml of the sample solution and heating to 80 C. The magnetic stirrer was switched on, and the beads were allowed to absorb copper for 5-6 hours. After the absorption period, one bead was placed into the graphite furnace for atomic absorption spectrometry. Copper may be determined at levels above 2 pg/ml in tap and distilled waters. (Cassar-PTT)
W88-05359

**DETERMINATION OF TRACE SULFIDES IN TURBID WATERS BY GAS DIALYSIS/ION CHROMATOGRAPHY,**
Alberta Environmental Centre, Vegreville.
L. R. Goodwin, D. Francom, A. Urso, and F. P. Dieken.
Analytical Chemistry ANCHAM, Vol. 60, No. 3, p 216-219, 1 February 1988. 7 fig, 7 tab, 19 ref.

Descriptors: *Sulfides, *Turbidity, *Dialysis, *Gas chromatography, *Pollutant identification, Colorimetry, Water analysis, Ions, Zinc, Drinking water, Well water, Wastewater analysis.

The accuracy of the methylene blue colorimetric procedure for the determination of sulfide in environmental waters and wastewaters is influenced by turbidity interference even after application of recommended pretreatment techniques. The direct analysis of sulfide by ion chromatography (IC), without sample pretreatment is complicated by field preservation of samples with zinc ion (or equivalent). A continuous-flow procedure has been developed which converts the acid-extractable sulfide to hydrogen sulfide, which is separated from the sample matrix by a gas dialysis membrane and then trapped in a dilute sodium hydroxide solution. A 200-microliter portion of this solution is injected into the ion chromatograph for analysis with an electrochemical detector. Detection limits as low as 1.9 ng/ml have been obtained. Good agreement was found the gas dialysis/IC and methylene blue methods for nonturbid standards. The addition of ascorbic acid as an antioxidant is required to obtain adequate recoveries from spiked tap and well waters. (Author's abstract)
W88-05360

**CHEMICAL CHANGES OF ORGANIC COMPOUNDS IN CHLORINATED WATER. XIV. CHARACTERIZATION AND DETERMINATION OF HALOGENATED ORGANICS FORMED DURING CHLORINATION OF WATER FROM THE TAMA RIVER,**
Tokyo Univ. of Science (Japan). Faculty of Pharmaceutical Sciences.
S. Onodera, T. Nishikawa, and S. Suzuki.
Journal of Chromatography JOCRAM, Vol. 409, p 259-270, November 13, 1987. 6 fig, 2 tab, 42 ref.

Descriptors: *Pollutant identification, *Fate of pollutants, *Water treatment, *Water analysis, *Organic compounds, *Chlorination, Chlorinated hydrocarbons, Tama River, Japan, Disinfection, Trihalomethanes, Halogenated organics, Hydrogen ion concentration.

Water samples collected from the Tama River were treated with chlorine under the conditions utilized for water renovation, in order to characterize and determine the halogenated organics formed in this reaction. The concentrations and compositions of organic halogens in chlorinated river water depend strongly on the sampling points. Chlorinated river water showed total trihalomethane (THM) levels ranging from 26 to 96 micrograms/liter. Higher concentrations of THMs and a high ratio of brominated THMs to total THMs were found on chlorination of water samples taken from the midstream of the Tama River, as compared with those observed from the upstream. The range of non-purgeable (NPOX) and n-hexane-extractable organic halogen (EOX) levels in the chlorinated river water was from 146 to 417 micrograms/liter, respectively. Gas chromatographic analyses of n-hexane extracts demonstrated that chlorine treatment of river water not only produces, in addition to THMs, new lower-molecular-weight and chromatographable organic halogen compounds (COX), but also decomposes the original halogenated organics present. The amounts of THMs, COX, EOX and NPOX in chlorine-treated river-water depended on the pH of the solutions. (Author's abstract)
W88-05365

**SIMPLIFIED METHOD TO QUANTIFY GEOSMIN AND 2-METHYLISOBORNEOL CONCENTRATIONS IN WATER AND MICROBIOLOGICAL CULTURES,**
Agricultural Research Service, New Orleans, LA. Southern Regional Research Center.
P. B. Johnsen, and J.-C W. Kuan.
Journal of Chromatography JOCRAM, Vol. 409, p 337-342, November 13, 1987. 5 tab, 8 ref.

Descriptors: *Pollutant identification, *Water treatment, *Gas chromatography, *Taste, Water analysis, Geosmin, 2-Methylisoborneol, Microbiological studies, Taste-producing algae, Algae.

A rapid, simple method for quantification of geosmin (trans-1,10-dimethyl-trans-9-decalol) and 2-methylisoborneol (MIB) uses methylene chloride extraction and gas chromatography, eliminating stripping devices. These compounds, which produce earthy, musty flavors in water supplies, have extremely low threshold sensitivities: 10 ng/liter for geosmin and 30 ng/liter for MIB. Recovery efficiency for the method was about 65% . The theoretical detection limit was 19.23 ng/liter of MIB and 9.61 ng/liter of geosmin. (Cassar-PTT)
W88-05366

**ANALYSIS OF BROMACIL, DIURON AND 3,4-DICHLOROANILINE IN CONTAMINATED WELL WATER, USING A HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC COLUMN-SWITCHING PROCEDURE,**
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. for Organic-Analytical Chemistry.
C. E. Goewie, and E. A. Hogendoorn.
Journal of Chromatography JOCRAM, Vol. 410, No. 1, p 211-216, November 1987. 2 fig, 17 ref.

Descriptors: *Chromatography, *Pollutant identification, *Well water, *Pesticides, *Herbicides, Diuron, Bromacil, Dichloroaniline, Water analysis, Groundwater pollution.

Precolumn switching was used to improve existing high-performance liquid chromatographic methods for analysis of diuron and its metabolite, 3,4-dichloroaniline, as well as to include the analysis of bromacil. Two column-switching methods were compared: one aimed at cleanup of redissolved organic extracts of water samples, the other involving direct sampling of a considerable volume (50 ml) of the water sample, in order to combine the preconcentration and cleanup function in a single procedure. Only the first method (redissolved extract cleanup) gave good qualitative and quantitative results. This step was followed by reversed-phase high-performance liquid chromatography. Mean recoveries were bromacil, 94%; 3,4-dichloroaniline, 69%; and diuron, 100%. (Cassar-PTT)
W88-05367

**SPECTROPHOTOMETRIC FIELD MONITOR FOR WATER QUALITY PARAMETERS: THE DETERMINATION OF PHOSPHATE.**
Hull Univ. (England). Dept. of Chemistry.
Analytica Chimica Acta ACACAM, Vol. 197, p 43-50, June 15, 1987. 4 fig, 13 ref.

Descriptors: *Phosphates, *Pollutant identification, *Monitoring, *Data acquisition, *Spectrophotometry, Photometry, Measuring instruments, Phosphorous compounds, Silicon, Silicates, Interference, Water analysis, Natural waters, Detection limits.

A flow-injection manifold based on reagent injection into the sample stream is described for the determination of phosphate in natural waters. A double-beam photometric detector incorporating light-emitting diodes and photodiodes in enclosed in a 20-cu cm box. The response is linear over the range 0-2000 micrograms/liter phosphate-phosphorus (r = 0.9992) and the limit of detection (2sigma) is 12 micrograms/liter phosphorus. The reagents are stable for at least 30 days and there is no interference from 10 milligrams/liter silicate-silicon. (Author's abstract)
W88-05377

**NOVEL ADSORBENT FOR THE DETERMINATION OF THE TOXIC FRACTION OF COPPER IN NATURAL WATERS,**
Commonwealth Scientific and Industrial Research Organization, Lucas Heights (Australia).Div. of Energy Chemistry.
M. P. Zhang, and T. M. Florence.
Analytica Chimica Acta ACACAM, Vol. 197, p 137-148, June 15, 1987. 3 fig, 10 tab, 17 ref.

Descriptors: *Adsorbents, *Copper, *Pollutant identification, *Data acquisition, Algae, Heavy metals, Natural waters, Toxicity, Aluminum hydroxide, Resins, Copper compounds, Bioassay, Comparison studies, Metals, Monitoring.

A novel adsorbent for the determination of the toxic fraction of copper in natural waters is described. Aluminum hydroxide adsorbed on a sulfonic acid cation-exchange resin quantitatively retains copper(II) ions in the absence of organic ligands such as fulvic, humic and tannic acids. In the presence of these ligands, a smaller fraction of copper is adsorbed and can be related to the toxic fraction. The toxic fraction determined by this method agrees well with results of algal assay with the marine diatom Nitzschia closterium in seawater and the green alga Chlorella pyrenoidosa in a synthetic soft water. The aluminum hydroxide-coated column also quantitatively adsorbs lipid-soluble copper complexes, which can be leached selectively from the column with methanol. The Al:OH ratio on the resin was 1:2 and the conditional stability constants (log K) of the Cu(2+)-adsorbent complexes in seawater and synthetic soft water were 9.87 and 11.10, respectively; these values are similar to the equilibrium constants for the reaction between Cu(2+) and algae. The application of this adsorbent in an in-situ instrument for the continuous, unattended determination of the toxic fraction of copper and some toxic metals in natural waters is outlined. (Author's abstract)
W88-05378

**DETERMINATION OF COPPER IN NATURAL WATERS BY ATOM-TRAPPING ATOMIC ABSORPTION SPECTROMETRY AFTER LIQUID/LIQUID EXTRACTION,**
Sheffield Univ. (England). Dept. of Chemistry.
S. Bradshaw, A. J. Gascoigne, J. B. Headridge, and J. H. Moffett.
Analytica Chimica Acta ACACAM, Vol. 197, p 323-325, June 15, 1987. 1 tab, 3 ref.

Descriptors: *Atomic absorption spectrometry, *Copper, *Pollutant identification, *Data acquisition, Atom-trapping method, Heavy metals, Photometry, Extraction, Natural waters, Comparison studies.

Copper at levels of 1-100 nanograms/ml is determined in natural waters by atom-trapping atomic absorption spectrometry after extraction of its 1-pyrrolidinecarbodithioate complex into isobutylmethylketone. Results were in good agreement with those obtained by conventional carbon-furnace atomic absorption spectrometry and the method is recommended when carbon-furnace atomic absorption spectrometry is not available. The atom-trapping method is somewhat slower because of the additional time needed for extraction and atom-trapping (about 6 minutes more per sample). It is 165 more sensitive than conventional flame atomic absorption spectrometry. (Wood-PTT)
W88-05379

**SULFURIC ACID CLEANUP AND KOH-ETHANOL TREATMENT FOR CONFIRMATION OF ORGANOCHLORINE PESTICIDES AND POLYCHLORINATED BIPHENYLS: APPLICATION TO WASTEWATER SAMPLES,**
University Coll. of Castellon (Spain). Environmental Lab.
F. H. Hernandez, F. J. L. Benet, J. M. Escriche, and J. C. B. Ubeda.
Journal - Association of Official Analytical Chemists JANCA2, Vol. 70, No. 4, p 727-733, July/August 1987. 6 fig, 3 tab, 20 ref.

Descriptors: *Chlorinated pesticides, *Pollutant identification, *Wastewater analysis, *Monitoring, Measuring instruments, Wastewater pollution, Pesticides, Chlorinated hydrocarbons, Polychlorinated biphenyls, Agricultural chemicals, Farm wastes, Sulfuric acid, Sample preparation, Gas chromatography, Spain.

A simple, rapid method was developed for the determination of organochlorines in wastewater samples periodically collected in a predominantly agricultural area in Spain. The efficacy of the sulfuric acid cleanup and KOH-ethanol hydrolysis confirmation was examined for 22 organochlorine pesticides and 2 polychlorinated biphenyls. Mean recoveries for different treatment times are given. The wastewater samples were analyzed by gas chromatography with electron capture detection. Organochlorine compounds were extracted by using separatory funnels and 15% diethyl ether in hexane as the extractant. All of the compounds examined could be analyzed except trifluralin, dichloran, dieldrin, and endrin, which were destroyed after treatment with concentrated H2SO4. The pesticides most commonly found in the samples analyzed were fenson, tetradifon, lindane, methoxychlor, and dicofol. (Wood-PTT)
W88-05391

**CAPILLARY COLUMN GAS CHROMATOGRAPHIC DETERMINATION OF TRACE RESIDUES OF THE HERBICIDE CHLORSULFURON IN AGRICULTURAL RUNOFF WATER,**
Alberta Environmental Centre, Vegreville.
I. .Ahmad.
Journal - Association of Official Analytical Chemists JANCA2, Vol. 70, No. 4, p 745-748, July/August 1987. 4 fig, 13 ref.

Descriptors: *Chlorsulfuron, *Gas chromatography, *Pollutant quantification, *Data acquisition, Measuring instruments, Herbicides, Agricultural runoff, Pollutants, Runoff, Trace levels, Chromatography, Detection limits, Water pollution, Pollutant identification, Chemical reactions.

A capillary column gas chromatographic method is described for determining parts-per-trillion (ppt) levels of chlorsulfuron in agricultural runoff water. The water sample is acidified with acetic acid and extracted with methylene chloride. The chlorsulfuron in the extract is derivatized to its monomethyl derivative. After Florisil column cleanup, the methylated chlorsulfuron is determined by electron capture gas chromatography. Recovery of chlorsulfuron from fortified water samples is greater than 80%. Detection limit of the method is 25 nanograms chlorsulfuron/liter water (25 ppt). There are two reaction sites on the chlorsulfuron molecule, both of which are susceptible to methylation leading to monomethyl chlorsulfuron and dimethyl chlorsulfuron. A procedure is described to methylate selectively the sulfonamide nitrogen of chlorsulfuron. (Author's abstract)
W88-05392

**CHEMICAL CONTAMINANTS MONITORING: PESTICIDE RESIDUES IN LAKE ALBUFERA, VALENCIA, SPAIN,**
Universidad Politecnica de Valencia (Spain). Dept. of Biotechnology.
For primary bibliographic entry see Field 5B.
W88-05393

**FASTER, CHEAPER ASSAY FOR TOXINS,**
J. Alper, and B. J. Spaulding.
Chemical Week CHWKA9, Vol. 141, No. 18, p 40-41, October 28, 1987.

Descriptors: *Analytical methods, *Bioassay, *Toxic wastes, *Toxicity, *Mitochondria, Water quality, Organic chemicals, Enzymes, Sensitivity.

A new assay for toxic chemicals that uses bits of membrane from mitochrondria has been developed. The assay could find use in monitoring water quality and in determining effluent toxicity. The present toxicity test approved by the Environmental Protection Agency uses minnows. The mitochondrial assay has an 82% correlation with the minnow assay. It yields results in < 10 min and should cost about $2/assay. The assay detects about 90% of known toxic chemicals. Mitochondrial membrane contains enzymes that generate energy, principally in the form of adenosine triphosphate (ATP). ATP is produced by five enzyme clusters which are particularly sensitive to damage by toxins, thus giving the assay its sensitivity. Any or all of the five enzyme complexes involved in oxidative phosphorylation can be manipulated. In oxidative phosphorylation, enzymes in complexes I and II oxidize such substrates as malate and succinate to obtain electrons. The electrons are transferred from complex I or complex II, respectively, to complex III, then to complex IV and finally to oxygen. During each transfer, complex V produces ATP. In essence, the sequence is little more than a series of oxidation-reduction reactions. More assays that make use of the sensitivity of oxidative phosphorylation to a variety of toxins are being developed. (Alexander-PTT)
W88-05427

**RELATIVE SENSITIVITIES OF ENVIRONMENTAL LEGIONELLAE TO SELECTIVE ISOLATION PROCEDURES,**
Olin Corp., Cheshire, CT. Olin Research Center.
K. P. Roberts, C. M. August, and J. D. Nelson.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 12, p 2704-2707, December 1987. 6 tab, 10 ref.

Descriptors: *Pollutant identification, *Legionellae, *Bacterial analysis, *Water analysis, *Antibiotics, Sample preparation, Cooling water, Culture media, Agars.

A survey of water samples to determine the efficacy of standard procedures for the isolation of environmental legionellae was conducted. Marked variations in intraspecies resistance to selective agents and treatments were observed, and in experiments with one of the isolates, the response was modified by culture conditions. Five selective procedures incorporating acid (pH 2) and heat (50 C, 30 min) treatments, with and without plating on buffered charcoal-yeast extract agar supplemented with vancomycin (5 microgram/ml), polymyxin B (60 U/ml), and cycloheximide (80 microgram/ml), caused 5 to 99% decreases in viable counts of pure cultures in water suspensions. The differences in the responses of the cultures to the five treatments were statistically significant. Cells in retained samples of naturally contaminated water from which the original cultures had been isolated were significantly less sensitive than artificially grown isolates. The sensitivities of the laboratory-grown cells to the treatments were affected by the length of incubation on buffered charcoal-yeast extract agar. Whereas acid resistance increased after 24 hours of incubation, resistance to the antibiotic mixture decreased. (Author's abstract)
W88-05445

**ENUMERATION OF VIBRIO CHOLERAE O1 IN BANGLADESH WATERS BY FLUORESCENT-ANTIBODY DIRECT VIABLE COUNT,**
Maryland Univ., College Park. Dept. of Microbiology.
P. R. Brayton, M. L. Tamplin, A. Huq, and R. R. Colwell.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 12, p 2862-2865, December 1987. 1 tab, 21 ref. National Institutes for Health Public Health Service grant R22-AI-14242, U. S. Aid for International Development grant DOE-542-G-55-4060-00, Word Health Organization grant C6/181/70.

Descriptors: *Pollutant identification, *Water analysis, *Vibrio, *Bacteria, *Fluorescence microscopy, Cholera, Bangladesh, Microscopy, Microbiological studies, Bacterial analysis, Developing countries.

A field trial to enumerate Vibrio cholerae O1 in aquatic environments in Bangladesh was conducted, comparing fluorescent-antibody direct viable count with culture detection by the most-probable-number index. Specificity of a monoclonal anti-

body prepared against the O1 antigen was assessed and incorporated into the fluorescence staining method. All pond and water samples yielded higher counts of viable V. cholerae O1 by fluorescent-antibody direct viable count than by the most-probable-number index. Fluorescence microscopy is a more sensitive detection system than culture methods because it allows the enumeration of both culturable and nonculturable cells and therefore provides more precise monitoring of microbiological water quality. (Author's abstract)
W88-05449

**COMPARISON OF FOUR MEMBRANE FILTER METHODS FOR FECAL COLIFORM ENUMERATION IN TROPICAL WATERS,**
Puerto Rico Univ., Rio Piedras. Dept. of Biology.
J. Santiago-Mercado, and T. C. Hazen.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 12, p 2922-2928, December 1987. 1 fig, 8 tab, 29 ref. Water Resources Research Institute of the University of Puerto Rico grant, Sea Grant R/LR-08/87-THA1, National Institutes of Health Public Health Servicegrants RR-2657 and RR-8102.

Descriptors: *Pollutant identification, *Water analysis, *Coliforms, *Bacterial analysis, *Membrane processes, *Filtration, *Tropical regions, Puerto Rico, Estuaries, Wastewater pollution, Culture media, Indicators, Bioindicators, Escherichia coli.

Four membrane filter methods for the enumeration of fecal coliforms were compared for accuracy, specificity, and recovery. Water samples were taken several times from 13 marine, 1 estuarine, and 4 freshwater sites around Puerto Rico, from pristine waters and waters receiving treated and untreated sewage and effluent from a tuna cannery and a rum distillery. Differences of 1 to 3 orders of magnitude in the levels of fecal coliforms were observed in some samples by different recovery techniques. Marine water samples gave poorer results, in terms of specificity, selectivity, and comparability, than freshwater samples for all four fecal coliform methods used. The method using Difco m-FC agar with a resuscitation step gave the best overall results; however, even this method gave higher false-positive error, higher undetected-target error, lower selectivity, and higher recovery of nontarget organisms than the method using MacConkey membrane broth, the worst method for temperate waters. All methods tested were unacceptable for the enumeration of fecal coliforms in tropical fresh and marine waters. Thus, considering the high densities of fecal coliforms observed at most sites in Puerto Rico by all these methods, it would seem that these density estimates are, in many cases, grossly overestimating the degree of recent fecal contamination. Since Escherichia coli appears to be a normal inhabitant of tropical waters, fecal contamination may be indicated when none is present. Using fecal coliforms as an indicator is grossly inadequate for the detection of recent human fecal contamination and associated pathogens in both marine and fresh tropical waters. (Author's abstract)
W88-05452

**TESTING FOR BACTERIAL RESISTANCE TO ARSENIC IN MONITORING WELL WATER BY THE DIRECT VIABLE COUNTING METHOD,**
Maryland Univ., College Park. Dept. of Microbiology.
J. L. Zelibor, M. W. Doughten, D. J. Grimes, and R. R. Colwell.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 12, p 2929-2934, December 1987. 3 fig, 4 tab, 16 ref. U. S. Geological Survey contracts PO166077 and PO173487 1985-86.

Descriptors: *Water pollution effects, *Bioindicators, *Pollutant identification, *Arsenic, *Bacterial analysis, *Water analysis, *Heavy metals, Monitoring, Groundwater pollution, Wells, Metals, Direct viable counting method, Microbiological studies, Aberdeen Proving Grounds, Maryland, Adaptation, Biotransformation.

Direct viable counting of metal-resistant bacteria (DVCMR) has been found to be useful in both enumerating and differentiating metal-resistant and metal-sensitive strains of bacteria. The DVCMR bioassay was used to detect effects of low and high concentrations of arsenic and arsenicals on bacterial populations in groundwater. The level of resistance of the bacterial populations to arsenate was determined by the DVCMR bioassay, and the results showed a linear correlation with the total arsenic concentrations in the monitoring well water samples; no correlation was observed by culture methods with the methods employed. Bacteria resistant to 2,000 micrograms of arsenate per ml were isolated from all monitoring well water samples studied. Strains showed similar antibiotic and heavy-metal profiles, suggesting that the arsenic was not a highly selective pressure for arsenic alone. The monitoring well water samples were amended with arsenate and nutrients to determine the biotransformation mechanisms involved. Preliminary results suggest that bacteria indigenous to the monitoring well water samples did not directly transform, i.e., precipitate or volatilize, dissolved arsenic. It was concluded that arsenic contamination of the groundwater can be monitored by the DVCMR bioassay. (Author's abstract)
W88-05453

**DETECTING UNDERGROUND PIPING LEAKS,**
Groundwater Technology, Inc., Annapolis Junction, MD.
T. Schwendeman.
Civil Engineering CEWRA9, Vol. 57, No. 8, p 56-58, August 1987.

Descriptors: *Water pollution sources, *Pressure-measuring instruments, *Pipes, *Leakage, *Underground structures, Storage, Monitoring, Tanks, Storage tanks.

Strategies for detecting leaks in underground pipes carrying potential pollutants of groundwater may use a positive pressure system, a negative pressure system, external sensing, or a combination. The positive pressure system uses a 60 psi pressure gauge. Any decrease more than 5 psi indicates a possible leak. Continuous mechanical line pressure monitors rely on a pressure-sensing, diaphragm-operated valve. Electronic monitoring systems, not yet in wide use, measure decrease in pressure over time. In a negative pressure piping system the operator can monitor the liquid dispensing device. If a leak is present, air will enter the pipe as liquid drains back into the tank through the check valve or into the surrounding environment. Hydraulic testing is the most common direct tightness testing method. Indirect tightness testing involves the application of a full system tightness test performed on a completely filled underground system. First the tank is tested, then the piping. External systems monitor the environment outside the system for the presence of pollutants leaking from the piping system. Vapor monitoring and liquid detection cable systems may be used for this purpose. Piping systems may be surrounded by a containment system which prevents leaks from migrating into the environment. These techniques include impervious barriers of plastic material, double-walled pipe installation, and concrete encasement. (Cassar-PTT)
W88-05478

**REMOVAL OF TOXIC MATERIALS FROM IN SITU TAR SAND PROCESS WATER,**
Oklahoma State Univ., Stillwater. School of Civil Engineering.
For primary bibliographic entry see Field 5D.
W88-05523

**EFFECTS OF BLEACHED KRAFT MILL EFFLUENT ON EARLY LIFE STAGES OF BROWN TROUT (SALMO TRUTTA L.),**
Finnish Game and Fisheries Research Inst., Helsinki. Fisheries Div.
For primary bibliographic entry see Field 5C.
W88-05571

**RESPONSES OF TROUT FRY (SALMO GAIRDNERI) AND XENOPUS LAEVIS TADPOLES TO CADMIUM AND ZINC,**
Southampton Univ. (England). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W88-05575

**EFFECT OF INORGANIC SALTS AND ADSORPTION IN SEPHADEX-GEL CHROMATOGRAPHY OF AQUATIC ORGANIC SUBSTANCES,**
Ceskoslovenska Akademie Ved, Prague. Ustav Krajinne Ekologie.
J. Hejzlar.
Water Research WATRAG, Vol. 21, No. 11, p 1311-1318, November 1987. 7 fig, 1 tab, 23 ref.

Descriptors: *Salts, *Inorganic compounds, *Water analysis, *Chromatography, *Pollutant identification, Pollutants, Organic matter, Organic compounds, Hydrogen ion concentration, Adsorption, Molecular weights, Distribution patterns.

Effects of inorganic salts in Sephadex-gel chromatography of aquatic organic substances were studied using Sephadex G-15 and samples of peatbog water, river water, and a secondary effluent. A substantial proportion of organic substances from all the water types showed a pH-dependent reversible adsorption affinity to the gel matrix. The presence of inorganic salts in the samples before fractionation can manifest itself in entirely misleading results of the separation of organic substances according to their molecular weights, since it causes the formation of peaks of organic substances. These peaks appear due to the changes in pH within the column during elution of inorganic salts and contain molecules of similar adsorptive and dissociative properties rather than those of similar molecular weights. Sephadex-gel chromatography can be used for the correct determination of molecular weight distribution of aquatic organic substance provided that no retention processes other than entropy-controlled size exclusion governs the behavior of the solute in the gel. The influence of inorganic salts can be avoided by eliminating their gradients between samples and eluents. Sephadex-gel chromatography seems to be limited value in the analysis of molecular weights of aquatic organic substances. (Wood-PTT)
W88-05586

**OCCURRENCE OF ROTAVIRUSES AND ENTEROVIRUSES IN RECREATIONAL WATERS OF OAK CREEK, ARIZONA,**
Arizona Univ., Tucson. Dept. of Microbiology and Immunology.
For primary bibliographic entry see Field 5B.
W88-05595

**USE OF MOSS-BAGS FOR MONITORING HEAVY METALS IN RIVERS,**
Durham Univ. (England). Dept. of Botany.
M. G. Kelly, C. Girton, and B. A. Whitton.
Water Research WATRAG, Vol. 21, No. 11, p 1429-1435, November 1987. 5 fig, 4 tab, 24 ref.

Descriptors: *Pollutant identification, *Heavy metals, *Moss-bags, *Monitoring, Rivers, Water pollution, Pollutants, Zinc, Cadmium, Lead, Metals, Accumulation, Mosses, Simulation.

Methods were developed for the use of aquatic mosses in mesh bags to monitor heavy metal pollution by measuring concentrations in 2-cm tips of the widespread species, Rhynchostegium riparioides and (in one experiment) Fontinalis antipyretica. Intermittent pollution events were simulated by transporting moss from streams with low concentrations to ones with high concentrations of zinc, cadmium, and lead and also, in one case, back from high to low concentration. Factors affecting accumulation were also studied; these included position inside the bag, density of packing, mesh size and differences between moss on boulders and in bags. In general, these factors influenced accumulation only slightly over a wide range of treatments. In a river, metals would be accumulated by the moss whenever a pollutant discharge occurred

during the period of exposure and the amount of metal retained would be a function of the length of exposure. The influence of the amount of time for which moss was exposed to pollution on subsequent loss was tested for zinc: a greater proportion was lost over the first 2 hours in moss exposed for 1 hour than 24 hours. Therefore, successful detection of a discharge of short duration requires sample collection within a few hours of the occurrence of the discharge. The potential for using the moss-bag technique is discussed: it is robust and convenient to handle and is recommended for monitoring heavy metals in stretches of rivers where there are no natural moss populations. (Wood-PTT)
W88-05602

**DETERMINATION OF PHOSPHORUS IN NATURAL WATER USING HYDRIDE GENERATION AND GAS CHROMATOGRAPHY,**
National Research Inst. for Metals, Tokyo (Japan).
For primary bibliographic entry see Field 2K.
W88-05608

**TOXICITY OF METHYLENE CHLORIDE TO LIFE STAGES OF THE FATHEAD MINNOW, PIMEPHALES PROMELAS RAFINESQUE,**
Dow Chemical Co., Midland, MI. Dept. Health and Environmental Sciences.
D. C. Dill, P. G. Murphy, and M. A. Mayes.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 5, p 869-876, November, 1987. 3 tab, 11 ref.

Descriptors: *Methylene chloride, *Chlorinated hydrocarbons, *Toxicity, *Minnows, *Growth stages, Fish, Embryonic growth stage, Larval growth stage, Halomethanes, Water quality standards.

The chronic toxicity of methylene chloride to fathead minnow was studied to illustrate the differences in toxicity of the halomethanes. Studies included a 192-h flow-through acute test and a 32-day embryo-larval test. The 96-h LC50 was estimated to be 502 mg/l, and the 192-h LC50 was 471 mg/l. A sublethal effect, loss of equilibrium, was observed at concentrations > 357 mg/l. The maximum acceptable toxicant concentration, based on body weight, was estimated to lie between 82.5 and 142 mg/l, and is 108 mg/l expressed as the geometric mean of these two values. The acute/chronic ratio is 4.6, indicating a small difference between acute and chronic effects. The percent larval survival data showed that approximately 50% of the mortalities at each treatment level occurred within four days of the day-to-mean hatch, and greater than 95% of the mortalities had occurred within 14 days of hatch. It is concluded that the generic grouping of methylene chloride with other halomethanes will result in an unrealistically low aquatic life criterion for methylene chloride. (Doria-PTT)
W88-05622

**ACIDIC PRECIPITATION IN SOUTHEASTERN ARIZONA: SULFATE, NITRATE AND TRACE-METAL DEPOSITION,**
Princeton Univ., NJ. Center for Energy and Environmental Studies.
For primary bibliographic entry see Field 2K.
W88-05631

**CLASSIFICATION OF SUSPENDED PARTICLES IN DEPOSITION SAMPLES AND RUN-OFF WATER SAMPLES FROM A LIMESTONE CATHEDRAL,**
Antwerp Univ., Wilrijk (Belgium). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W88-05635

**ANALYSIS OF STATISTICAL MONITORING NETWORK DESIGN,**
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W88-05636

**MUSSELWATCHING IN THE BUFFALO RIVER, TIMES BEACH AND LAKE ERIE,**
Army Engineer Waterways Experiment Station, Vicksburg, MS.
J. M. Marquenie, D. K. Crawley, and J. W. Simmers.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A181 627. Price codes: A03 in paper copy, A01 in microfiche. Report No. R 86/199, November 11, 1986. 32 p, 4 fig, 4 tab, 13 ref, 2 append.

Descriptors: *Bioindicators, *Mussels, *Times Beach, *Buffalo, *New York, *Lake Erie, *Water pollution effects, Polychlorinated biphenyls, Pesticides, Buffalo River, Bioaccumulation, Dikes, Tissue analysis, Monitoring.

Mussels, Elliptio dilatata, were collected from a pristine lake and exposed in the Buffalo River, Lake Erie and a confined disposal site, Times Beach, Buffalo, New York. The mussels were exposed in a natural way, allowing them to burrow in the sediment or between stones. After a period of about 35 days the mussels were recollected and analyzed from PCBs, DDE and HCB. The Buffalo River was found to contain bioavailable PCB's and pesticides in three stretches only: (1) The two main branches, before they merge into the navigable stretch; (2) A stream passing through several industrial estates downstream of Cazenovia Creek. This stretch is probably affected by an industrial discharge of a mixture comparable to Aroclor 1260; and (3) The mouth of the Buffalo River between the Marina and the Coast Guard Station. In Lake Erie, indications were found for a gradient in PCB concentration. Mussels exposed in Times Beach, were found to accumulate large amounts of lower chlorinated PCBs and pesticides. Remarkably, they did not accumulate any significant amounts higher chlorinated PCBs (hexa- and heptachloro-biphenyls). The gamut of PCB congeners in mussels exposed on either side of the endikement enclosing Times Beach revealed no evidence of bioavailable PCBs being transported from Times Beach into Lake Erie. (Author's abstract)
W88-05720

**STORAGE AND PRESERVATION OF ENVIRONMENTAL SAMPLES,**
Oak Ridge National Lab., TN.
M. P. Maskarinec, and R. L. Moody.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-004271. Price codes: A02 in paper copy, A01 in microfiche. Report No. CONF-870410--11, (1987). 10 p, 3 ref. EPA Contract No. 40-1744-86, and DW89932002-01-0.

Descriptors: *Environmental samples, *Water quality control, *Sample preservation, *Sampling, *Sample preservation, *Water analysis, *Explosives, Water sampling, Organic compounds, Chemical analysis.

The chemical analysis of environmental samples is complicated by the lack of a definitive data base establishing the allowable preanalytical holding times for such samples. This study is designed to establish the preanalytical holding times for volatile organic compounds in water and soil, and explosives in water and soil, under various storage conditions. Procedures are also being developed to reproducibly prepare the large number of samples necessary to create such a data base. (Lantz-PTT)
W88-05749

**EFFECT OF TREATMENT ON ASSIMILABLE ORGANIC CARBON IN DRINKING WATER,**
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
For primary bibliographic entry see Field 5F.
W88-05828

**SPATIAL HETEROGENEITY OF WATER QUALITY PARAMETERS,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 7C.
W88-05863

**UNCERTAINTY IN WATER QUALITY DATA,**
Colorado State Univ., Fort Collins. Environmental Engineering Program.
For primary bibliographic entry see Field 7C.
W88-05864

**SULPHATE, WATER COLOUR AND DISSOLVED ORGANIC CARBON RELATIONSHIPS IN ORGANIC WATERS OF ATLANTIC CANADA,**
Inland Waters Directorate, Ottawa (Ontario). Water Quality Branch.
G. D. Howell, and T. L. Pollock.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 53-63, 2 fig, 6 tab, 13 ref.

Descriptors: *Water analysis, *Statistics, *Pollutant identification, *Water quality, *Sulfates, *Color, *Dissolved organic carbon, *Canada, Organic compounds, Colorimetry, Chemical analysis, Statistical analysis, Regression analysis.

A large data set was utilized to reexamine some of the difficulties associated with the determination of sulfate concentrations in highly organic waters. As a result of color interference (e.g. organic anions) of colorimetric sulfate determinations and the inability to quantitatively determine organic anion concentrations, analytical laboratories often perform parallel colorimetric and ion chromatographic sulfate analyses. Using sulfate data from Atlantic Canada, a water color threshold value of 20 Hazen units, below which there is no significant difference between the two analytical techniques can be established. Eighteen data sets were examined to determine whether or not historical colorimetric sulfate concentrations could be corrected for organic anion interference. Nine of these data sets not only had good linear relationships (r-squared > = .65) between delta SO4 (SO4 sub MTB - SO4 sub IC) and water color but also exhibited similar slopes. Similar results were observed for relationships between delta SO4 and dissolved organic carbon, although the correlation coefficients were lower than those observed for the delta SO4 versus color regressions. These results indicate that correction of SO4 sub MTB data for headwater sites or sites draining one or more headwaters (i.e. those which have highly variable water colors) can be accomplished using a general correction equation. (See also W88-05862) (Author's abstract)
W88-05867

**SULFATE IN COLOURED WATERS. I. EVALUATION OF CHROMATOGRAPHIC AND COLORIMETRIC DATA COMPATIBILITY,**
Canada Centre for Inland Waters, Burlington (Ontario).
V. Cheam, A. S. Y. Chau, and S. Todd.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 64-78, 17 fig, 6 tab, 19 ref.

Descriptors: *Statistics, *Sulfates, *Color, *Water quality, *Pollutant identification, *Chromatography, *Colorimetry, Data interpretation, Chemical analysis, Organic carbon, Methyl thymol blue.

The compatibility and reliability of colorimetric and chromatographic SO4 data were evaluated. The multiple standard addition technique was applied to numerous natural and humic acid fortified waters. A total of more than 20 different waters was used, in which the color ranged from 50 to 440 Hazen units and the organic carbon from 0.7 to 20 ppm. For the first time, it was demonstrated that ion chromatography (IC) data on organic-contaminated colored waters are reliable. It was also confirmed that the Methyl Thymol Blue (MTB) colorimetric data were biased high. An approach for salvaging historical colorimetric data was found and is briefly summarized as follows: (1) There is no simple and universal correction factor which readily converts the historical data to true SO4

values; and (2) for a specific amount and nature of organic matter, there exists a relationship between SO4 determined by MTB and SO4 determined by IC. Thus, to salvage historical MTB data, one simply obtains case by case the two types of SO4 values, relates them by a polynomial equation, and interpolates the corresponding historical values to obtain the expected true SO4 values. The case by case treatment can involve a specific site, river, lake, or a group of them which have a similar amount and nature of organic matter. (See also W88-05862) (Lantz-PTT)
W88-05868

**ESTIMATION OF DISTRIBUTIONAL PARAMETERS FOR CENSORED WATER QUALITY DATA,**
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 7C.
W88-05872

**STATISTICAL INFERENCES FROM COLIFORM MONITORING OF POTABLE WATER,**
For primary bibliographic entry see Field 7C.
W88-05875

**MODELLING OF BACTERIAL POPULATIONS AND WATER QUALITY MONITORING IN DISTRIBUTION SYSTEMS,**
Centre des Sciences de l'Environment, Metz (France).
A. Maul, A. H. El-Shaarawi, and J. C. Block.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 194-214, 5 fig, 3 tab, 15 ref.

Descriptors: *Statistics, *Statistical models, *Bacteria, *Water quality control, *Monitoring, *Metz, *France, Water distribution, Spatial distribution, Temporal distribution, Microbiological studies, Data interpretation, Sampling.

Bacteriological surveys were performed on the drinking water distribution system of the city of Metz in France, according to a systematic sampling design to determine the spatial and temporal distribution of heterotrophic bacteria in the network. A non-hierarchical nearest-centroid clustering method was used for dividing the water distribution system into zones corresponding to different levels of bacterial density. Since the frequency distributions of microorganisms within the zones could be modelled by the negative binomial distribution, the water distribution system studied may be considered as being composed of several heterogeneous subsystems. Information on the spatial and temporal variability of bacteriological data was used to develop a sampling design for use in future water quality monitoring. Under the assumption that the objective of monitoring is to determine whether or not the mean bacterial density of the water exceeds a specific standard, a criterion is given which determines the optimal number of sampling stations allocated to each zone in case of a one-run sampling design. These stations are determined by assuming that either the risk of sampling (i.e., making the wrong decision) is prespecified or that the total number of stations to be sampled is predetermined. (See also W88-05862) (Author's abstract)
W88-05876

**REPORTING BACTERIOLOGICAL COUNTS FROM WATER SAMPLES: HOW GOOD IS THE INFORMATION FROM AN INDIVIDUAL SAMPLE,**
Central Public Health Lab., London (England). Communicable Disease Surveillance Centre.
H. E. Tillett.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 221-230, 2 fig, 4 tab, 7 ref.

Descriptors: *Statistics, *Bacterial analysis, *Water sampling, Statistical analysis, Performance evaluation, Microbiological studies, Drinking water, Membrane filtration.

In Britain, bacteriological examination of drinking and recreational waters is often assessed using the multiple dilution ('multiple tube') method or, if not, by the membrane filtration technique. Evidence from quality control trials, where replicate simulated specimens were issued to volunteer laboratories, shows that coliform counts from membrane filtration tended to be lower than the intended result. The multiple tube method was more sensitive in detecting the bacteria in waters with low contamination. Membrane filtration gives a precise count whereas the multiple tube method gives an estimated count which should be qualified by a range of probable counts. Published tables of most probable numbers (MPN) of bacteria use exponential approximations which require the assumption that the water examined comes from a large body of homogeneous water. Some MPN's have been recalculated without making any such assumption and using occupancy theory. It is suggested that, in situations where there are close contenders for the title MPN, a range of probable numbers should be quoted rather than a single MPN. If the bacteriological content of the water is being compared with a Standard, then the question becomes whether the whole of the 'probable range' of counts should pass this Standard. The bacteriological result from a single water sample should be reported with care. It should be made clear that it represents that place at that time only. It gives no information about likely ranges of counts at the water source, except in the unlikely situation that the sample comes from a homogeneous body of water. (See also W88-05862) (Author's abstract)
W88-05878

**IMPLICATIONS OF SUBSURFACE BIOLOGICAL ACTIVITY FOR MONITORING UNDERGROUND STORAGE TANKS,**
Robert S. Kerr Environmental Research Lab., Ada, OK.
B. H. Wilson.
IN: Processes Affecting Subsurface Transport of Leaking Underground Tank Fluids. EPA Report No. EPA/600/6-87/005, June 1987. p 61-66, 12 ref.

Descriptors: *Fate of pollutants, *Underground storage, *Biomonitoring, *Bioindicators, *Leaking, Microbiological studies, Soil bacteria, Nutrients, Chemical reactions, Chemical analysis, Monitoring, Iron, Oxygen, Methane.

The vast majority of microbes in the subsurface are firmly attached to soil particles. As a result, nutrients must be brought by advection or diffusion through the mobile phases, water and soil gas. In the most common case, the organic compounds to be consumed for energy and cell synthesis is brought in aqueous solution in infiltrating water. At the same time oxygen, the electron acceptor used to oxidize the carbon source, is brought be diffusion through the soil gas. In the unsaturated zone, volatile organic compounds can also move readily as vapors in the soil gas. Blow the water table all transport must be through liquid phases, and as a result the prospects for aerobic metabolism is severely limited by the very low solubility of oxygen in water. In the final analysis, predictions of biological activity encompass: (1) The stoichiometry of the metabolic process; (2) The concentration of the required nutrients in the mobile phases; (3) The advective flow of the mobile phases or the steepness of concentration gradients within the phases; (4) The opportunity for colonization of the subsurface by metabolically capable organisms; and (5) The toxicity exhibited by the waste or a co-occurring material. Biological processes have two obvious implications for monitoring releases from underground storage tanks. Soil microbes can consume a small leak and can prevent the spread of organic contaminants; in this way they effectively mask the presence of the leak. In this role biological activity protects the quality of associated groundwater, but it greatly complicates the task of monitoring for a leak by chemical analysis for compounds originally present in the tank. The second implication follows from the first. If release of organic materials elicits biological activity, it may be more convenient to monitor for some other consequence of metabolism, particularly if the concentration of the released material is reduced below the analytical detection limit. The most promising candidates are: (1) reduction in oxygen concentration; (2) increase in soluble iron; (3) methane production; and (4) a reduction in electrode potential associated with changes in the redox status of the subsurface environment. (See also W88-05901) (Lantz-PTT)
W88-05905

**PESTICIDE ASSESSMENT GUIDELINES, SUBDIVISION E, HAZARD EVALUATION: WILDLIFE AND AQUATIC ORGANISMS,**
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
C. E. Laird.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-207700. Price codes: A04 in paper copy, A01 in microfiche. Series 72-1 to 72-5, Aquatic Testing for Marine/Estuarine and Freshwater Fish and Invertebrates: Addendum 2 on Data Reporting. EPA Report No. EPA-540/09-87-198, December 1986. 65 p, 25 tab.

Descriptors: *Guidelines, *Pesticides, *Water pollution effects, *Fish, *Aquatic environment, *Invertebrates, Estuaries, Marine environment, Shrimp, Oysters.

The Data Reporting Guideline (DRG) for Aquatic Testing for Marine/Estuarine and Freshwater Fish and Invertebrates, series 72-1 to 72-5, gives guidance to pesticide registrants on the format for their study report so that the Agency can review it efficiently. It clarifies sections in the existing Pesticides Assessment Guidelines, Subdivision E, on data reporting and provides an outline for study reports and describes the topics and the order in which they should be addressed. This DRG actually contains guidance for reports on nine topics: 72-1, Acute Toxicity Test for Freshwater Fish; 72-2, Acute Toxicity Test for Freshwater Aquatic Invertebrates; 72-3, Acute Toxicity Test for Shrimp; 72-3, Acute Toxicity Test for Estuarine and Marine Fish; 72-3, Oyster Embryo Test; 72-3 Shell Deposition Study for Oyster; 72-4, Fish Early Life-Stage; 72-4, Aquatic Invertebrate Life-Cycle; and 72-5, Life Cycle Tests for Fish. Data submitters can use the DRG in preparing their reports for submission to EPA to meet 40 CFR 158 requirements for the registration of pesticides. (Author's abstract)
W88-05906

## 5B. Sources Of Pollution

**ORGANOCHLORINE AND PCB RESIDUES IN LAKE ERIE MINK POPULATIONS,**
Alberta Environmental Centre, Vegreville.
G. Proulx, D. V. C. Weseloh, J. E. Elliott, S. Teeple, and P. A. M. Anghem.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 939-944, 1987. 1 fig, 2 tab, 18 ref.

Descriptors: *Polychlorinated biphenyls, *Mink, *Chlorinated hydrocarbons, *Path of pollutants, *Bioaccumulation, Food chain, Tissue analysis, Organic compounds, Fish.

PCB poisoning has been found in mink (Mustela vison) fed on Great Lakes fish but its occurrence in wild mink populations is poorly knowns. The objective of this study was to determine whether mink from the Lake Erie basin were accumulating levels of PCB and organochlorine residues high enough to cause health effects. The skinned carcasses of 55 wild mink caught in November and December 1978 and 1979, and from January to March 1979, were obtained from trappers through the Ontario Ministry of Natural Resources. PCBs were quantified by capillary gas chromatography against a 1:1 standard mixture of Aroclor 1254:1260. Geometric means were calculated for all residue data as a measure of central tendency because of the logarithmic distribution of the data. The logarithmic means of the residues were compared to each other in analyses of variances and t-tests. Levels of PCB 1254/1260 detected in mink

body homogenates varied from 0.06 to 7.37 ppm, on a wet weight basis, and from 0.8 to 117.7 ppm, on a lipid weight basis. Analyses of variance showed a significant difference between the logarithmic means of the mink samples on a wet weight basis and on a lipid weight basis. Both sets of data indicated that mink samples from Mersea and Dunn-Rainham Townships in Ontario had very high mean PCB levels, similar ($p > 0.05$) to each other but significantly ($p < 0.005$) greater than those of other regions. (Alexander-PTT)
W88-05108

**FLUORIDE POLLUTION IN A SALT MARSH: MOVEMENT BETWEEN SOIL, VEGETATION, AND SHEEP,**
Centraal Diergeneeskindig Inst., Lelystad (Netherlands).
A. J. Baars, H. van Beek, T. J. Spierenburg, G. J. de Graaf, and W. G. Beeftink.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 945-952, 1987. 3 fig, 2 tab, 16 ref.

Descriptors: *Fluorides, *Salt marshes, *Sheep, *Path of pollutants, *Bioaccumulation, Food chain, Tissue analysis, Seasonal variation, Bioavailability, Grasses.

The occurrence of fluoride, an environmental contaminant known to be spread by water and air, was investigated in the salt marshes of the River Scheldt in the Netherlands. Soil and vegetation were sampled monthly from May 1983, to July 1984. Selected samples were also taken from October 1984, to May 1985. Soil samples were taken from 0.20 cm depth on high, middle and low locations on the marsh, based upon tidal submergence. Plants were taken from species commonly consumed by sheep. During the second period of investigation, samples of meadow grass were also taken at three locations on the land side of the dike. Sheep feces and urine were sampled monthly. Rib material was removed from sheep that died or were slaughtered during the study. Regularly, a veterinary inspection of the flock was done. The fluoride content ranges from 80 to 140 mg/kg dry matter, which does not particularly indicate pollution. In contrast to soil, the fluoride content of vegetation shows a seasonal variation, levels in early spring are about 4 times higher than in late summer. This indicates a relation with the growth cycle of the plants. Although this seasonal variation was seen in all species studied, there is also a considerable difference between species. A rough estimation of the fluoride balance of the sheep was made assuming a daily intake of 1.5 kg plant material (on a dry matter base)/animal, a manure production of 0.5 kg dry material/day and a urine production of 0.5 to 4 L/day. The average F content of the plant material was 52 mg/kg, the feces contained 14 mg/kg, and the mean urine concentration was 5 mg/L. Hence the bioavailability of the F appears to be about 65 to 90%. (Alexander-PTT)
W88-05109

**CHLORINATED PESTICIDE RESIDUES IN SEDIMENTS FROM THE ARABIAN SEA ALONG THE CENTRAL WEST COAST OF INDIA,**
National Inst. of Oceanography, Panaji (India).
A. Sarkar, and R. S. Gupta.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 1049-1054, 1987. 1 fig, 1 tab, 12 ref.

Descriptors: *Path of pollutants, *Chlorinated hydrocarbons, *Halogenated pesticides, *Pesticides, *Sediments, *Arabian Sea, India, DDD, DDT, DDE, Organic compounds, Fate of pollutants, Metabolites.

An attempt was made to identify and quantify some of the chlorinated pesticide residues in marine sediments collected from different region along the central west coast of India. Residues of BHC, Aldrin, Dieldrin, pp'-DDT, op'-DDT, pp'-DDE, op'-DDE and pp'-DDD were identified and quantified in the sediments; op'-DDD was not detected in any of the sediment samples collected. This may be attributed to the fact that the conversion of this particular metabolite from op'-DDT is very unlikely in the marine environment. Among the organochlorine pesticides detected, BHC was detected in almost all the sediment samples at concentration between 0.44 and 17.9 ng/g. Aldrin was detected in a few of the sediment samples; its concentration was within the range, 0.95 to 35.7 ng/g. Dieldrin was detected in only one sample. This may be attributed to the limited use of this particular pesticide. As far as the presence of DDT and its metabolites are concerned it was observed that pp'-DDT was detected only in four out of fourteen samples collected so far, whereas op'-DDT was detected only in two samples. Among the metabolites of DDT,pp'-DDE and op'-DDE (44.6 ng/g) were estimated from the sediment sample collected from the Ratnagiri coast whereas that of op'-DDE (159 ng/g) was detected from the sediment near the Marmagao coast. This may be expected due to the considerable degradation of DDT to DDE in the coastal sediments. Unlike DDE, pp'-DDD was detected in one sediment sample only. The conversion of pp'-DDT to pp'-DDD is very insignificant in the marine sediments. On the other hand, the conversion of DDT to DDE is fairly considerable in the marine sediments. The residue levels of all the organochlorine pesticides detected so far are in the following order: Dieldrin < pp'-DDD < op'-DDE < pp'-DDT < pp'-DDE < Aldrine < BHC. (Alexander-PTT)
W88-05118

**FACTORS INFLUENCING THE ACCUMULATION OF SEDIMENT-SORBED HEXACHLOROBIPHENYL BY MIDGE LARVAE,**
Tennessee Univ., Knoxville. Dept. of Zoology and Entomology.
C. M. Swindoll, and F. M. Applehans.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 1055-1062, 1987. 6 fig, 12 ref.

Descriptors: *Path of pollutants, *Bioaccumulation, *Polychlorinated biphenyls, *Midges, *Larvae, *Sediments, Organic compounds, Biodegradation, Population exposure, Substrates.

The importance of abiotic and biotic factors to the bioaccumulation of sediment-sorbed hydrophobic organic compounds by benthic organisms was studied. Hexachlorobiphenyl (HCB) was chosen as the model substrate because it is extremely stable and shows no indication of being biodegradable and thus is representative of organic compounds which pose the greatest ecological hazard. Factors examined were substrate type, organic content of substrate, concentration, temperature and biological viability. The bioaccumulation of HCB resulting from exposure to contaminated substrate was characterized by an initial phase of rapid uptake followed by a progressively slower accumulation. The rapidity of bioaccumulation was probably the result of the HCB concentration gradient which existed when the midges were initially exposed to the contaminated substrate; midge HCB uptake slowed as equilibrium concentrations were approached. Steady-state concentrations were obtained in all experiments within 4 to 5 days exposure. HCB bioaccumulation from different contaminated substrates was significantly different and followed this sequence: natural sediment (ns) < oxidized sediment (OS) < sand (sa) < kaolinite (KA) which is approximately the inverse of that of the surface area of the substrates. The data indicate that the physical process of equilibrium partitioning was responsible for HCB bioaccumulation from contaminated sediment. However, biological activity contributed to this partitioning process and would be expected to be important to bioaccumulation in the environment. The bioavailability of HCB was inversely related to surface area and organic content of the substrate, and proportional to concentration. (Alexander-PTT)
W88-05119

**INVESTIGATION OF AMERICAN LOBSTER, HOMARUS AMERICANUS, FOR THE PRESENCE OF CHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS,**
Ontario Ministry of the Environment, Rexdale. Lab. Services Branch.
R. E. Clement, H. M. Tosine, V. Taguchi, C. J. Musial, and J. F. Uthe.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 1069-1075, 1987. 1 fig, 2 tab, 13 ref.

Descriptors: *Path of pollutants, *Polychlorinated dibenzodioxins, *Polychlorinated dibenzofurans, *Lobsters, Effluents, Tissue analysis, Industrial wastes, Isomers, Organic compounds.

American lobsters (Homarus americanus) on the Atlantic coast of Canada were investigated for the presence of polychlorinated dibenzo-p-dioxin (PCDD) and polychlorinated dibenzofuran (PCDF). Sample site 1 is within the Miramichi River estuary which receives input from a wood-preservation plant. Site 2 is within Chaleur Bay approximately 13 km from a lead smelter. Sites 3 and 4 are in the South Arm and mouth of Sydney Harbor. The South Arm of Sydney Harbor receives the effluent from a coal-coking plant and steel mill which has resulted in substantial contamination of lobsters by polycyclic aromatic hydrocarbons. Site 5 is distant from known sources of PCDD and PCDF and served as the control sample site. No tetrachloro dibenzo-p-dioxin (TCDD) congeners were detected in any of the samples, while tetrachloro dibenzofuran (TCDF) was the only congener found in all samples. The higher chlorinated congeners (hepta, octa) predominated for PCDD, the lower chlorinated congeners (tetra, penta) were the most abundant for PCDF. Composite samples taken near sources of known pollution (sites 1,2,3) exhibited greater PCDD and PCDF concentrations than samples from remote locations (site 5). Average digestive gland PCDD concentrations were 22 ppt in lobsters captured near contamination sources. No PCDDs were detected in the 'clean' area sample. Average PCDF concentrations were 400 ppt in contaminated samples and 60 ppt in clean area samples. Isomer patterns are important because they may give clues to the specific sources of pollutants. For hexachlorinated and heptachlorinated PCDD and PCDF, within-congener isomer patterns were the same in all samples where these compounds were detected. Patterns for TCDF were also similar in all samples, except for the relative abundance of one peak which eluted at the correct retention time for 2,3,7,8-TCDF. This peak varied from 5% to 47% of total TCDF. The percent of total TCDF for this peak is 28% (1), 7% (2,3), 13% (4) and 35% (5). (Alexander-PTT)
W88-05121

**ORGANOCHLORINE AND METAL POLLUTION IN AQUATIC ORGANISMS SAMPLED IN THE DONANA NATIONAL PARK DURING THE PERIOD 1983-1986,**
Consejo Superior de Investigaciones Cientificas, Madrid (Spain). Inst. de Quimica Organica General.
C. Rico, L. M. Hernandez, J. Gonzalez, M. A. Fernandez, and M. C. Montero.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 1076-1083, 1987. 2 fig, 4 tab, 6 ref.

Descriptors: *Path of pollutants, *Pollutant identification, *Polychlorinated biphenyls, DDT, DDE, *Organochlorine compounds, *Heavy metals, Fish, Crayfish, Eels, Frogs, Cadmium, Copper, Zinc, Lead, Mercury, Aquatic animals, Bioaccumulation.

Samples of aquatic organisms were obtained from the principal waterway of Donana National Park of SW Spain to determine the degree of organochlorine and metal contamination. The aquatic species chosen for analysis were: American crayfish (Procambarus clarckii), carp (Cyprinus carpio), barbel (Barbus barbus), grey mullet (Mugil capito), eel (Anguilla anguilla), and frog (Rana perezi). DDE residues were detected in all of the fish, none of these were above the critical level of 1 ppm. PCBs were detected in all samples, but only two species, from Huerta de las Arenas (Anguilla anguilla) and Canal del Cherry (Cyprinus carpio)

were above the critical level of 0.5 ppm. Overall residue appeared greater in eels than those detected in the other fish. Heavy metals were detected in all of the samples. Levels of metals decreased in order Zn > Cu > Pb > Hg > Cd. No significant difference could be observed in pollutant residue concentrations due to location, and only significant differences in PCB concentrations were observed from the three years; the major accumulation of these pollutants was observed in 1985, in general. There are highly significant positive correlations between HCHt/DDTt, PCBs/DDTs, Cd/Pb, Cd/Cu, Cd/Zn, Pb/Cu, Pb/Zn, and Cu/Zn; there are significant positive correlations between Hg/DDTt and Hg/PCBs. These correlations may be the result of similar storage characteristics or similar distribution patterns in ecosystems. (Alexander-PTT)
W88-05122

**EXAMINATION OF SOX, NOX AND TRACE METAL WASHOUT RATIOS OVER THE WESTERN ATLANTIC OCEAN,**
General Motors Research Labs., Warren, MI. Environmental Science Dept.
G. T. Wolff, T. M. Church, J. N. Galloway, and A. H. Knap.
Atmospheric Environment ATENBP, Vol. 21, No. 12, p 2623-2628, December 1987. 3 tab, 19 ref.

Descriptors: *Acid rain, *Sulfur oxides, *Nitrogen oxides, *Water pollution sources, *Trace metals, *Bermuda, *Path of pollutants, Precipitation, Air pollution, Sulfates, Nitrates.

During January and February 1983, simultaneous measurements of sulfur oxides, nitrogen oxides and some trace metals were made in both air and precipitation samples on Bermuda. Washout ratios for a variety of species were calculated. From the trace metal data, it was estimated that the mean washout ratio for fine particles (diameter < 2.5 microns) is on the order of 270. Washout ratios for fine SO4(2-) are 2-14 times greater. This finding and the observation that the NH4(+)/SO4(-) molar ratio is lower in precipitation than in the particulate phase suggests that in-cloud SO2 oxidation is occurring. Fine- and coarse-diameter (2.5-10 microns) particulate NO3(-) plus HNO3 appear to account for the NO3(-) in precipitation for most of the events. (Author's abstract)
W88-05123

**CONCENTRATION AND DEPOSITION OF NITRATE, SULFATE AND AMMONIUM AS A FUNCTION OF WIND DIRECTION FROM PRECIPITATION SAMPLES,**
State Univ. of New York at Stony Brook. Lab. for Planetary Atmospheres Research.
K. R. Sperber.
Atmospheric Environment ATENBP, Vol. 21, No. 12, p 2629-2641, December 1987. 11 fig, 3 tab, 37 ref.

Descriptors: *Acid rain, *Path of pollutants, *Nitrates, *Sulfates, *Ammonium, *Water pollution sources, *Winds, *Precipitation, Regional analysis, Ions, Air pollution, Storms, New York, Statistical analysis.

The log sub e concentrations of nitrate, sulfate and ammonium are normally distributed. The t-test (using the log sub e transformed data) indicates the mean concentration of nitrate and sulfate in hourly precipitation samples, obtained at Brookhaven National Laboratory on Long Island, east of the New York Metropolitan region, to be greatest (> or = 95% confidence level) when associated hourly averaged wind direction is from the southwest, west and northwest regions (each region is a 45 deg interval of wind direction). Ammonium concentration is significantly greater when winds are from the southwest and west. Nitrate deposition is significantly greater when winds are from the southwest and west with a secondary peak in the southeast. Ammonium deposition behaves in a similar fashion to sulfate deposition. Moving statistics (using the untransformed data) confirm these findings and provide additional information on the behavior of the species distribution as a function of wind direction. For each species the relative standard deviations, calculated after normalizing the log sub e concentrations in each region to their respective means, are systematically smaller in the west. This is consistent with the expectation of lower variability about the axis of pollutant input from the main source region. At better than a 99.9% confidence level the F-test indicates nitrate concentrations to be more variable than sulfate concentrations. This indicates nitrate to be of local origin and sulfate to be transported over long distances and more uniformly mixed in comparison. These results indicate that the Lagrangian history of a storm system may be represented from data taken in the Eulerian reference frame. The moving statistics indicate the association of concentration and precipitation rate to be directionally and species dependent. (Author's abstract)
W88-05124

**ACID RAIN IN THE TROPICAL FORESTS OF THE IVORY COAST,**
Toulouse-3 Univ. (France). Lab. d'Aerologie.
J. P. Lacaux, J. Servant, and J. G. R. Baudet.
Atmospheric Environment ATENBP, Vol. 21, No. 12, p 2643-2647, December 1987. 6 fig, 3 tab, 6 ref.

Descriptors: *Acid rain, *Africa, *Ivory Coast, *Precipitation, *Water pollution sources, Regional analysis, Tropical forests, Climate, Acidity.

The first results concerning acidity of the precipitation collected over a period of 1 year (February 1983-March 1984) in an undisturbed area of tropical forest in the Ivory Coast are presented. A large proportion of the precipitation is acid, 77% has a pH below 5.6. The average acidity is 5.0, with a temporal evolution tending towards a basic pH during the dry season, characteristic of the influence of the Sahelian terrigenous dust source, and tending towards an acid pH of about 4.2 at the beginning of each humid period. This result, new for an African tropical forest, confirms the observations made in the Amazonian forests or in those of Northern Australia. An extensive research program on the acidity in the equatorial areas has been started in the forests of the Ivory Coast and Congo in order to confirm this preliminary study. (Author's abstract)
W88-05125

**MIDWEST/WESTERN/EASTERN U.S. PRECIPITATION AND AEROSOL SULFATE: DIFFERENCES ATTRIBUTABLE TO NATURAL SOURCE INPUTS,**
Colorado Univ., Denver. Dept. of Physics.
H. Sievering.
Atmospheric Environment ATENBP, Vol. 21, No. 12, p 2525-2530, December 1987. 3 tab, 17 ref.

Descriptors: *Air pollution sources, *Precipitation chemistry, *Aerosols, *Acid rain, *Sulfates, Regional analysis, Minnesota, Colorado, Ions, Acidity.

Factor analysis comparisons between the MAP3S network and Minnesota precipitation chemistry data show marked differences. An assessment of ambient aerosol and precipitation chemistry data obtained at several Colorado and Minnesota sites suggests that natural source inputs may contribute to the sulfate observed in ambient aerosol and, at least partly, explain the marked differences of Minnesota and Colorado precipitation chemistry data from that of MAP3S (eastern U.S.). However, a recently proposed mechanism, SO2 to SO4 conversion on the surface of dust particles, may be more important than natural sources in explaining western and midwestern precipitation chemistry data. It is concluded that these predominantly nonacidic SO4 sources may explain the poor association between the H(+) and SO4 in many western and some midwestern precipitation chemistry data sets. (Author's abstract)
W88-05126

**UNDERSTANDING GROUNDWATER MONITORING,**
For primary bibliographic entry see Field 7B.
W88-05130

**PETROLEUM POLLUTION IN THE CARIBBEAN,**
National Oceanic and Atmospheric Administration, Miami, FL. Atlantic Oceanographic and Meteorological Labs.
D. K. Atwood, F. J. Burton, J. E. Corredor, G. R. Harvey, and A. J. Mata-Jimenez.
Oceanus OCEAAK, Vol. 30, No. 4, p 25-32, Winter 1987/88. 7 fig, 4 ref.

Descriptors: *Water pollution sources, *Caribbean, *CARIPOL, *Oil pollution, Beaches, Petroleum, Recreation, Water pollution effects.

The Intergovernmental Oceanographic Commission (IOC) worked cooperatively with a Steering Committee of regional scientists to design a program that would (1) provide necessary information, and (2) allow laboratories from throughout the region to participate without expensive, sophisticated equipment to determine the severity of the petroleum pollution problem and monitor its effects. UNEP provided funds to train participants, and for symposia to present, discuss and publish the results. The program was named CARIPOL, for CARIbbean POLlution research and monitoring, and the Steering Committee designed a program to monitor three parameters related to petroleum pollution: (1) Tar on beaches; (2) Floating tar; and (3) Dissolved/dispersed petroleum hydrocarbons (DDPH). During the following six years, CARIPOL participants provided data on more than 9,000 observations throughout the region. A significant level of petroleum pollution exists throughout the Wider Caribbean. Manifestations of this pollution include serious tar contamination of windward exposed beaches, high levels of floating tar within the major currents system, and very high levels of dissolved/dispersed hydrocarbons in surface waters. The sources of petroleum pollution in the region include oil entering from the adjacent North Atlantic (50%) and tanker ballast washings (50%). Effects of this petroleum pollution include: (1) tar levels on many beaches that either prevent recreational use, or require expensive clean-up operations, (2) probable distress and death to marine organisms, such as endangered turtles who feed on floating tar; and (3) responses in the enzyme systems of marine organisms that have been correlated with declines in reproductive success. (Alexander-PTT)
W88-05132

**CHERNOBYL: OCEANOGRAPHIC STUDIES IN THE BLACK SEA,**
Woods Hole Oceanographic Institution, MA. Dept. of Chemistry.
K. O. Buesseler.
Oceanus OCEAAK, Vol. 30, No. 3, p 23-30, Summer 1987. 5 fig.

Descriptors: *Path of pollutants, *Chernobyl, *Radioactive fallout, *Water pollution sources, *Radionuclides, *Radioactivity, *Black Sea, Isotopes, Deposition, Scavenging.

Studies on the radioactive fallout from Chernobyl provide information about the fates of nuclear discharges to the environment, and about the circulation of the nearest body of salt water - the Black Sea. The major pathway for release of radioactivity was through volatilization during the fire. A second mechanism for radionuclide release was through mechanical processes, such as during the initial explosion when many small particles were generated from the reactor core material. The composition of the Chernobyl fallout has changed quite rapidly since its release as the result of radioactive decay. Of major immediate health concern were releases of iodine-131, and cesium-137. Iodine-131 is a highly toxic substance that is easily volatilized. More than a year later, essentially no I-131 remains. The radionuclide Cs-137 remains. Even after 100 years, 10 percent of the Cs-137 released by Chernobyl accident will still be present in the environment. Of the major Chernobyl radionuclides of concern, their half-lives range from a few days to many thousands of years. Using highly sensitive radiation detection techniques, Cs-134 and Cs-137 signals from Chernobyl were detected in the surface water samples. The data show

that at least some of the same Chernobyl radionuclides detected in the surface waters had been very rapidly removed to the trap at 1.071 meters - within less than 2 months of the initial fallout deposition at the surface. As expected by their differing chemistries, the removal rates for a more soluble element like cesium are much slower than that of the more particle-reactive cerium-144 and ruthenium-106. If the fluxes measured continue, the Chernobyl cesium-137 signal would take 100 to 200 years to be scavenged from the surface waters, while the cerium-144 and ruthenium-106 signals will be removed in only a matter of years. (Alexander-PTT)
W88-05133

**SALINITY MANAGEMENT MODEL: I. DEVELOPMENT,**
Ain Shams Univ., Cairo (Egypt). Dept. of Irrigation and Hydrology.
M. M. Nour el-Din, I. P. King, and K. K. Tanji.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 440-453, November 1987. 8 fig, 17 ref.

Descriptors: *Model studies, *Salinity, *Solute transport, *Leaching, *Path of pollutants, *Irrigation, *Salts, Bioaccumulation, Finite element method, Simulation, Mathematical equations, Drainage, Plants, Roots.

A finite element model to simulate salt accumulation and transport as well as under drainage in irrigated croplands is developed. The model simulates the flow of water and salts in a saturated-unsaturated soil system, including water uptake by plant roots. The finite element method is used to solve the mathematical equations that describe this problem, and the different components of the program are examined. An analysis is carried out on application efficiency, the quality of the applied water, and the irrigation schedule to ascertain their impacts on salinity levels in the soil profile. This model can evaluate the consequences of irrigation management decisions on the salt loads leached to the drainage system. An example of the model application is given. (See also W88-05135) (Author's abstract)
W88-05134

**SALINITY MANAGEMENT MODEL: II. 1- AND 2-D APPLICATIONS,**
Ain Shams Univ., Cairo (Egypt). Dept. of Irrigation and Hydrology.
M. M. N. el-Din, I. P. King, and K. K. Tanji.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 454-468, November 1987. 17 fig, 2 tab, 6 ref.

Descriptors: *Model studies, *Salinity, *Solute transport, *Path of pollutants, *Irrigation, *Salts, Bioaccumulation, Cotton, Tile drainage, Finite element method, Simulation, Mathematical equations, Drainage, Plants, Roots.

A finite element model to simulate salt flow and under-drainage for shallow water table conditions is used to simulate two illustrative cases. The first case involves a one-dimensional problem in which cotton is growing under conditions typical of the San Joaquin Valley of California. The second case involves a two-dimensional problem with a tile drain collecting excess water and salts from the field through several drain diameters. The model is capable of handling a wide variety of problems that often need scientific assessment, including salinity control and drainage. (See also W88-05134) (Author's abstract)
W88-05135

**EXPECTED PH FOR HALVING SULFATE IN ADIRONDACK RAIN,**
Systech Engineering, Inc., Lafayette, CA.
C. W. Chen, A. H. Johannes, S. A. Gherini, R. A. Goldstein, and E. R. Altwicker.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 979-993, October 1987. 9 fig, 1 tab, 29 ref.

Descriptors: *Adirondacks, *Sulfates, *Acid rain, *Pollutant identification, *Precipitation chemistry, Anions, Cations, Acidity, Rainfall, Hydrogen ion concentration.

The precipitation pH measured at the Woods Lake station in the Adirondack Mountains of New York fluctuated between 3.4-5.5 with a mean of 4.2 for the period extending from March 1978-December 1981. An analysis has been performed to identify the chemical factors causing these pH fluctuations. The pH of precipitation can be calculated from the sum of strong acid anions less the sum of base cations. The data showed that the sum of base cations increased with the sum of acid anions. However, there was only a 0.4 equivalent increase in base cations per equivalent increase in acid anions. Thus, precipitation in the Adirondacks was always acidic (pH <5.6). Analyses show an interdependency between cation and anion contamination processes. Because of this interdependency, a halving of the mean sulfate concentration from 60 micro-eq/L to 30 micro-eq/L would cause a shift of the mean precipitation pH from 4.20 to 4.35. If an equivalent decrease of hydrogen ions is assumed, the pH would change from 4.20 to 4.52. (Author's abstract)
W88-05161

**HYDROCARBONS IN URBAN RUNOFF,**
Clean Harbors, Inc., Braintree, MA.
S. Fam, M. K. Stenstrom, and G. Silverman.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 1032-1046, October 1987. 12 fig, 4 tab, 22 ref.

Descriptors: *Urban runoff, *Urban areas, *Water pollution sources, *Hydrocarbons, *San Francisco Bay, Runoff, Watersheds, Land use, Chromatography, Pollutant identification.

Runoff from 15 watersheds in the San Francisco Bay area was sampled over a 2-yr period and analyzed for hydrocarbons. Both gravimetric analyses and high-resolution gas capillary chromatography were performed. Land uses with high commercial/industrial activity had much greater aliphatic hydrocarbon emissions than non-commercial areas. A relationship between commercial land use and the anthropogenic aliphatic hydrocarbon fraction was found. The ratio of total extractable organics to total organic carbons varied with land use, with a ratio of six or more indicating significant commercial/industrial activity. Aromatic hydrocarbons, including polynuclear aromatics were found in smaller concentrations than aliphatics. (Author's abstract)
W88-05164

**EFFECT OF TEMPERATURE ON OXYGEN TRANSFER - LABORATORY STUDIES,**
North Carolina State Univ., Raleigh. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2K.
W88-05168

**DEGRADATION OF A COMMERCIAL SURFACTANT, IN THE PRESENCE OF A COMPLEMENTARY CARBON SOURCE, BY A BACTERIAL COMMUNITY SELECTED FROM A MARINE ENVIRONMENT. (DEGRADATION D'UN TENSIO-ACTIF COMMERCIAL, EN PRESENCE D'UNE SOURCE COMPLEMENTAIRE DE CARBONE, PAR UNE COMMUNAUTE BACTERIENNE SELECTIONNEE EN MILIEU MARIN),**
Aix-Marseille-3 Univ. (France). Faculte des Sciences et Techniques.
J. C. Sigoillot, and M. H. Nguyen.
Canadian Journal of Microbiology CJMIAZ, Vol. 33, No. 10, p 929-932, October 1987. 4 fig, 17 ref.

Descriptors: *Fate of pollutants, *Biodegradation, *Bacteria, *Surfactants, Degradation, Water pollution control, Detergents, Ecological effects, Ecosystems.

Bacterial communities that can degrade surfactants were selected from coastal seawaters contaminated by urban sewages. Only the linear fraction of commercial anionic surfactants was quickly degraded, and a residual fraction representing 10% of the initial concentration always remained. The highest concentrations of surfactant tolerated by these communities depend on the nature of the co-substrate and on the degree of adaptation of the selected bacteria. (Author's abstract)
W88-05174

**DISTRIBUTION OF CHEMICALS IN RIVERS DURING CONTAMINATION AND RECOVERY,**
Toronto Univ. (Ontario). Dept. of Chemical Engineering and Applied Chemistry.
D. Basmadjian, and F. Quan.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1185-1201, December 1987. 6 fig, 1 tab, 14 ref, 2 append.

Descriptors: *Path of pollutants, *Fate of pollutants, *Organic chemicals, *Rivers, *Recovery, *Model studies, Mathematical studies, Equations, Distribution, Sediments, Partition coefficients.

Differential equations that describe the fate of chemicals in rivers as they transfer, react, and volatilize, both during contamination and recovery are developed. Explicit analytical solutions are presented for the unsteady distribution of the substance in the aqueous and sediment phases assuming a constant partition coefficient. The solutions are expressed in terms of three parameters, dimensionless distance Z; dimensionless time T; and the conservation index K, which equals 1 for conservative nondegrading substances, and zero for infinitely fast loss or degradation. All three parameters are instrumental in defining limits for important asymptotic cases. Thus, for Z < or = 0.1, and under all conditions, the river compartmentalizes into sediment and aqueous phases of uniform concentration. T = 10 is the minimum time scale for a steady profile to be developed during contamination. During recovery, and for values of K < or = 0.1, the river (of whatever length) again reverts to compartments of uniform concentration. (Author's abstract)
W88-05175

**SEASONAL AND SPATIAL VARIATIONS IN MERCURY METHYLATION AND DEMETHYLATION IN AN OLIGOTROPHIC LAKE,**
Wisconsin Univ.-La Crosse. River Studies Center.
E. T. Korthals, and M. R. Winfrey.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 10, p 2397-2404, October 1987. 7 fig, 2 tab, 36 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Lakes, *Oligotrophic lakes, *Mercury, *Methylmercury, *Methylation, *Heavy metals, Metals, Demethylation, Lake Clara, Wisconsin, Seasonal variation, Seepage lakes, Lake sediments, Sediments, Chemical reactions, Bacteria, Decomposition.

Microbial mercury methylation and methylmercury decomposition were examined in Lake Clara, an oligotrophic northern Wisconsin seepage lake, using radioisotopic tracers. Methylation activity was near background in the water column, was greatest in the profundal surficial sediments, and decreased with depth in sediment cores. Active demethylation occurred in the water column but was variable. Demethylation was greatest in the surficial sediments and decreased slightly with sediment depth. The methylation/demethylation ratio (M/D) was >1 in the water column, exhibited a sharp peak in surface sediments, and decreased in deeper sediments. Methylation and demethylation activity varied in surface sediments collected along a lake transect. The M/D ratio in surface sediments ranged from 1.4 to 5.8. Methylation in attached microbial communities was near background, while demethylation was high. The M/D ratios in the attached communities were all <0.20. Methylation activity in surface sediments incubated at in situ temperature increased from spring to late summer and decreased in the fall. Demethylation increased from early to midsummer and then declined. The M/D ratio in surface sediments increased from mid- to late summer, and decreased in the fall. These results indicate that the

greatest potential for methylation in Lake Clara occurs in the surficial sediments and that methylation in surficial sediments is greatest from mid-July through September. In addition, the net rate of methylmercury production may be significantly affected by demethylation. (Author's abstract)
W88-05189

**PRODUCTION AND FATE OF METHYLATED SULFUR COMPOUNDS FROM METHIONINE AND DIMETHYLSULFONIOPROPIONATE IN ANOXIC SALT MARSH SEDIMENTS,**
State Univ. of New York at Stony Brook. Marine Sciences Research Center.
For primary bibliographic entry see Field 2L.
W88-05191

**ANEROBIC BACTERIA THAT DECHLORINATE PERCHLOROETHENE,**
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
For primary bibliographic entry see Field 5G.
W88-05195

**GROWTH DETERMINATIONS FOR UNATTACHED BACTERIA IN A CONTAMINATED AQUIFER,**
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5A.
W88-05196

**RELATION OF LENGTH AND SEX TO SELENIUM CONCENTRATIONS IN MOSQUITOFISH,**
National Fisheries Contaminant Research Center, Dixon, CA. Field Research Station-Dixon.
M. K. Saiki.
Environmental Pollution EPEBD7, Vol. 47, No. 3, p 171-186, 1987. 3 fig, 5 tab, 39 ref.

Descriptors: *Path of pollutants, *Pollutant identifications, *Network design, *Bioindicators, *Selenium, *Fish, Monitoring, Indicators, Mosquitofish.

Mosquitofish (Gambusia affinis) are commonly used to monitor contaminant levels in aquatic biota. For selenium analysis it is often necessary to combine several fish so that sufficient biomass is available. Significant differences in mean lengths and sex ratios of mosquitofish were found in fish sampled from five sites in the San Joaquin Valley, California. No consistent patterns were observed in selenium concentrations in fish of different length and sex. At one site females 31-45 mm long had higher concentrations of selenium than other sizes of females. Otherwise, selenium concentrations did not differ among size classes. Although concentrations differed between sexes at three sites, neither males nor females consistently had the higher concentrations. These variables should be considered when surveys and monitoring studies are designed. (Cassar-PTT)
W88-05197

**RUNOFF LOSSES FROM EIGHT WATERSHEDS AS INFLUENCED BY SOIL COVER CONDITION AND MANAGEMENT SYSTEMS AT EL RENO, OKLAHOMA,**
Oklahoma State Univ., Stillwater. Graduate Coll.
F. M. Eldoumi.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8626215. Ph.D Dissertation, 1986. 201 p, 19 fig, 18 tab, 105 ref, append.

Descriptors: *Water pollution sources, *Nonpoint pollution sources, *Surface runoff, *Sedimentation rates, *Soil erosion, Runoff rates, Watersheds, Sediment erosion, Erosion rates, Sediment load, Sediment yield, Enrichment, Nutrients, Nitrogen, Phosphorus, Oklahoma.

Nitrogen and phosphorus (P) losses in surface runoff water and sediment were investigated with eight 1.62-hectare watersheds in El Reno, Oklahoma having different soil cover and management practices. The physical, chemical, and mineralogical characteristics of the soils within these watersheds were studied. N and P losses from these watersheds under the conditions of the study were not agronomically significant, nor of eutrophic nature. The amount of soil eroded was lower than the tolerable level set by the Oklahoma Soil Conservation Service. Computation of the percent of N and P associated with the sediment and liquid runoff revealed that the control of soil erosion will basically eliminate N losses by runoff; however, the control of soil and water runoff losses is evidently equally important to reduce P losses. N and P enrichment ratios indicated that the concentrations of N and P in the eroded material, irrespective of the soil cover, were higher than their concentrations in the A horizons of the soils occurring in the watersheds. This finding indicates the selectivity of the erosion process with water for the colloidal soil fractions which adsorb these plant nutrients. The N and P enrichment ratios also revealed that under severe erosion the eroded materials tend to approximate the composition of the eroding soil; but with more moderate runoff there is a selective removal of the finer fractions. (Cremmins-AEPCO)
W88-05210

**FIELD AND BASIN SCALE WATER QUALITY MODELS FOR EVALUATING AGRICULTURAL NONPOINT POLLUTION ABATEMENT PROGRAMS IN A SOUTH FLORIDA FLATWOODS,**
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W88-05211

**GROUNDWATER CONTAMINATION FROM SEPTIC SYSTEMS RECEIVING DETERGENTS OF TWO TYPES OF FORMULATION,**
Wisconsin Univ.-Madison. Dept. of Water Chemistry.
B. J. Alhajjar.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8601085. Ph.D Dissertation, 1985. 371 p, 72 fig, 40 tab, 179 ref, 7 append.

Descriptors: *Water pollution sources, *Path of pollutants, *Water pollution effects, *Septic wastewater, *Phosphorus, *Detergents, *Groundwater pollution, *Nitrogen, Bacteria, Bacterial analysis, Viruses, Model studies, Linear programming, Carbonates, Phosphates, Clogging.

The effects of phosphorus-built (P-built) and P-free detergent formulations on the treatment of septic systems and on the quality of groundwater under coarse-textured soils close to discharge areas were investigated, emphasizing the potential movement of nitrogen, phosphorus, indicator bacteria, and poliovirus into the groundwater. Eight and nine systems receiving P-built and P-free detergents, respectively, were studied. Samples of effluent from the septic tanks and of groundwater from the vicinity of the systems were analyzed. Soil samples at the gravel-soil interface were collected to determine which systems were more prone to failure by biological clogging. Data were modeled for a five-county region in Wisconsin using stochastic simulation of a contaminant-transport model. Line multiple regression models represented the composition of septic tank effluent in relation to laundry detergents. Ammonium nitrogen (NH4-N) in effluent was mostly oxidized to nitrate in soil before reaching groundwater, but 2 of 8 P- and 3 of 9 CO3-built detergent systems leached more than 1 mg/L of NH4-N to groundwater. Neither detergent caused entry of more than 0.1 mg/L P into groundwater. Indicator bacteria in effluent did not reach groundwater. At one site, poliovirus entered and spread in groundwater from an otherwise properly functioning septic system. Alkalinity, temperature, cations, chloride, sodium adsorption ratio, electrical conductivity, solids biological oxygen demand, and counts of indicator bacteria were higher in effluents with P-built detergents. (Cremmins-AEPCO)
W88-05213

**THREE-DIMENSIONAL FINITE ELEMENTS MODELING OF POLLUTANT TRANSPORT IN AQUIFERS,**
Oklahoma State Univ., Stillwater. Graduate Coll.
P. C. Yuan.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8626251. Ph.D Dissertation, 1986. 293 p, 48 fig, 23 tab, 115 ref, 7 append.

Descriptors: *Model studies, *Path of pollutants, *Aquifers, *Groundwater pollution, *Finite element method, Numerical analysis, Error analysis, Groundwater movement, Water pollution sources, Saturated flow, Groundwater runoff.

Galerkin's finite element method for solving the three-dimensional solute transport in a saturated aquifer was developed and validated using existing analytical solutions of the dispersions in two and three dimensions and with available numerical models in two dimensions. The concentration was assembled at all nodes and solved on an IBM 3081K system. Validation of the model for a one-dimensional case indicates that increasing the number of elements near a pollutant source improves the accuracy. Away from the source, element size can be increased without sacrificing accuracy. Error analysis for the one-dimensional case indicates that error varies from 0% to 13% using 20 to 100 elements in the problem. Model results are in close agreement with the solutions of two two-dimensional models for the same set of parameters. In this case, the error varies between 0% to 38% and 0% to 57.5% for the two solutions for only one node. For other nodes, the error for the two solutions varies between 0% to 20% and 0% to 22%. The peclet number should be kept low where the concentrations are small. Results for validation against two cases of three dimensional analytical solutions, a point source and a line source, agree with those of the point and line source solutions. Applied to data for a landfill, chloride concentrations predicted by the model are in close agreement with observations from monitoring wells. (Cremmins-AEPCO)
W88-05214

**LASER FLUORESCENCE/FIBER OPTIC MONITORING OF GROUNDWATER CONTAMINANT BIODEGRADATION,**
Tufts Univ., Medford, MA. Dept. of Civil Engineering.
W. Chudyk.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-139761/AS. Price codes: A05 in paper copy; A01 in microfiche. Contract No. USGS 14-08-0001-G1302. Final Technical Report, November 1987. 75 p, 25 fig, 13 tab, 45 ref, append.

Descriptors: *Remote sensing, *Biodegradation, *Fluorescence, Monitoring, Groundwater pollution, Pollutant identification, Path of pollutants, Fate of pollutants, Analytical techniques, Calibration, Model aquifers, Computer programs.

A one-year research project was conducted to determine the utility of the remote laser-induced fluorescene/fiber optics groundwater contaminant detector (RLIF) technique for monitoring biodegradation processes in groundwater systems. The project involved construction, calibration, and use of bench and pilot-scale model aquifers in the laboratory, as well as use of RLIF to study such models, in order to understand better the transport and fate of groundwater contamination. (USGS)
W88-05233

**HEAVY METALS IN DRINKING WATERS FROM THE PARAIBA DO SUL - GUANDU RIVER SYSTEM, RIO DE JANEIRO STATE, BRAZIL,**
Universidade Federal do Rio de Janeiro (Brazil). Inst. de Biofisica.
J. M. Azcue, W. C. Pfeiffer, M. Fiazman, and O. Malm.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1181-1183, 1987. 1 fig, 1 tab, 2 ref.

Descriptors: *Heavy metals, *Path of pollutants, *Drinking water, *Water treatment, Pollutants, Water pollution, Pollutant identification, Brazil, Lead, Copper, Chromium, Zinc, Iron, Manganese, Water pollution sources, Industrial wastes.

The critical metals in the Paraiba do Sul - Guandu River System (PSR-GR), were determined and the tap waters supplied to local cities as well as the city of Rio de Janeiro were analyzed to evaluate the metal pollution. Results show that four metals (Pb, Cu, Cr and Zn) out of the eight released by the local industrial area are the critical metals in the PSR-GR system. Suspended particles are the main compartment in transporting these metals downstream. Analysis of the performance of tap water treatment plants pointed out that the main parameter for these treatment plants is the retention of suspended particles. Iron and manganese had the highest concentrations in drinking water. (Author's abstract)
W88-05248

**FIELD STUDIES ON THE BEHAVIOUR OF ORGANIC MICROPOLLUTANTS DURING INFILTRATION OF RIVER WATER TO GROUND WATER,**
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
C. Schaffner, M. Ahel, and W. Giger.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1195-1196, 1987. 1 tab, 4 ref.

Descriptors: *Organic compounds, *Path of pollutants, *Fate of pollutants, *Groundwater pollution, *Infiltration, Groundwater movement, River water infiltration, Phenols, Nitriliotriacetate, Rivers, Glatt River, Switzerland, Groundwater, Pollutants, Water pollution.

The fate of organic pollutants during groundwater infiltration is of great interest since many water works use bank filtration as a first step in the treatment of river water for public water supplies. Results are presented of field studies of the lower Glatt Valley in Switzerland on the behavior of organic chemicals such as pentachlorophenol (PCP), nonylphenol (NP), nonylphenol monoethoxylate (NP1EO), nonylphenol diethoxylate (NP2EO) and nitrilotriacetate (NTA) during infiltration of river water to groundwater. Observation wells at the field site allowed the sampling of freshly infiltrated water at distances varying between 2.5 and 14 meters from the river. NTA was eliminated rapidly during groundwater infiltration; starting in the river at 8-83 mg NTA/cu m, with an average of 27 mg/cu m, NTA concentration decreased to only 0.5 mg/cu m after 7 m of infiltration which corresponded to an elimination of 98%. The phenolic pollutants were eliminated according to the sequence: NP1EO = NP2EO > NP > PCP based on the decrease of the average concentrations over the first 7 m of infiltration. PCP was rather persistent in the groundwater. (Wood-PTT)
W88-05251

**LAND TREATMENT OF WASTEWATERS: A CASE STUDY OF IRRIGATED ARID ZONES,**
Centro de Economia, Legislation y Administracion del Agua, Mendoza (Argentina).
For primary bibliographic entry see Field 5E.
W88-05262

**CONTAMINATION OF GROUNDWATER BY SEPTIC TANK PERCOLATION SYSTEMS,**
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl und Pruefamt fuer Wasserguetewirtschaft und Gesundheitsingenieurwesen.
T. Ebers, and W. Bischofsberger.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1275-1279, 1987. 6 ref.

Descriptors: *Septic tanks, *Groundwater pollution, *Soil filters, *Wastewater treatment, *Water pollution sources, *Path of pollutants, Septic wastewater, West Germany, Wastewater, Filters, Soil contamination, Domestic wastes, Lysimeters.

In the Federal Republic of Germany, the barely treated wastewater of about 7 million people is percolated into the soil. Groundwater quality is a major concern, and investigations into soil filtration as a means of eliminating pollution from household wastewater were started. Experiments with six laboratory lysimeters (diameter = 0.4 meters, height = 1.8 meters) are described. Three lysimeters were filled with slightly silty sand, the other three with gravel sand. All lysimeters were in operation for about two years. Initially they were loaded with mechanically treated wastewater from a municipal treatment plant and later with effluent from a septic tank. Hydraulic loading varied from 0.5 to 31 cm/day. Results showed good efficiency for fine gravel sand (aerobic conditions) in removal of BOD5 (98.0 to 99.2%), COD (88.0 to 92.8%) and Kjeldahl nitrogen (90.0 to 91.3%). Elimination of phosphate ranged from 5.7 to 86.0%. Slightly silty sand (anaerobic conditions) showed the best results in the elimination of phosphate (86.0 to 99.3%) and relatively good elimination rates were achieved for BOD5 (65.0 to 98.2%) and COD (about 76%). Elimination of Kjeldahl nitrogen ranged from 39.6 to 68.4%. (Author's abstract)
W88-05270

**DOPPLER EFFECT TIED TO FLOW RATE,**
Polysonics, Inc., Houston, TX.
For primary bibliographic entry see Field 7B.
W88-05277

**SECOND REPORT ON THE WATER SUPPLY OF THE PEOPLE'S REPUBLIC OF CHINA,**
Zurich Water Supply (Switzerland).
M. Schalekamp.
Aqua AQUAAA, No. 5. p 229-241, 1987. 60 fig.

Descriptors: *Water pollution sources, *Water supply, *Water quality, *China, Kunming, Water treatment, Dian Lake, Drinking water, Flocculation, Filtration, Wastewater treatment, Water quality control, Water treatment facilities, Fate of pollutants, Pollutants.

Kunming, a high-altitude city known as an excellent health resort area, is located on Dian Lake which is extensively polluted in its upper regions. The origins of the lake pollutants, and concentrations of organic matter, nitrogen, phosphates, sulfide, heavy metals, and toxic substances are discussed. The lower part of Dian Lake, called the Waihia Lake, has an average phosphate content of 1000 micrograms/liter and will be used in the future as a source of drinking water. In order to protect Dian Lake from further contamination, sewage treatment facilities must be provided. Since the mechanical-biological process is insufficient for the protection of this lake, simultaneous flocculation equipment as well as a filtration facility are planned. Approximately 200 liters/inhabitant/day are presently distributed, but more is required. A fifth water supply plant, which will depend on the Waihia Lake as its source, will be constructed shortly. Details of the present waterworks are supplied. The water supply systems for the cities of Shanghai and Beijing are reviewed. (Wood-PTT)
W88-05279

**IMPACT OF DAM RETURNS ON WATER QUALITY - MYTH OR REALITY,**
Compagnie Generale des Eaux, Paris (France).
T. Dupin, F. Dupres, and F. Philipps.
Aqua AQUAAA, No. 5, p 249-257, 1987. 11 fig, 11 tab, 8 ref.

Descriptors: *Water quality, *Dam releases, *Dams, France, Water quality control, Conductivity, Dissolved oxygen, Turbidity, Organic carbon, Metals, Taste, Organoleptic properties, Suspended solids, Water temperature, Pollutants.

An initial analysis of the impact of releases of the dam located on the Marne River in France on water quality was made. Quality parameters at the water point of the Neuilly-sur-Marne plants were studied in 1981, 1983, and 1986, years of the most important releases of the dam. During low water periods, the positive dilution effect by the dam was shown in TOC levels and conductivity. But returns involving deeper waters see a rise in turbidity and dissolved oxygen. However, whatever the period, when major flow changes occur (with or without restitution), turbidity, TOC, and permanganate-oxidizable organic matter increase abruptly. (Wood-PTT)
W88-05281

**GROUNDWATER VULNERABILITY MAPS,**
National Water Supply Co., Brussels (Belgium).
P. De Smedt, W. De Breuck, W. Loy, T. Van Autenboer, and E. Van Dijck.
Aqua AQUAAA, No. 5, p 264-267, 1987. 2 fig, 1 tab.

Descriptors: *Groundwater pollution, *Maps, *Path of pollutants, *Aquifers, *Groundwater, Belgium, Mapping, Subsurface mapping, Fate of pollutants, Permeability coefficient, Hydraulic properties, Aquifer characteristics.

Because a large part of the surface area in Flanders is built up, under cultivation or covered by roads, the quality of the groundwater in the predominantly sandy formations is threatened by pollutants from single point sources and large areas. A map outlining the vulnerability of groundwater was needed urgently in order to make decisions concerning location of industrial areas, waste disposal sites, roads, quarries, excavations and housing projects. Groundwater vulnerability maps were made showing the degree of contamination risk of the groundwater in the upper aquifer by contaminants infiltrating from the surface. Maps were created for three provinces in one year, but as a result of the time limit a scale of 1/100,000 was used and only a series of static factors were considered; no dynamic factors were used. A vulnerability scale was devised after classifying aquifers by rock composition, hydraulic conductivity, contaminant behavior, type of covering formations, depth of covering, covering hydraulic resistance, or in cases where there is no covering formation, the thickness of the unsaturated zone. The problems and shortcomings of the maps were discussed and appropriate caution in their use for planning is suggested. (Wood-PTT)
W88-05283

**STUDY OF THE NITROGEN CYCLE IN SANTANDER BAY (ESTUDIO DEL CICLO DEL NITROGENO EN LA BAHIA DE SANTANDER),**
Instituto Espanol de Oceanografia, Santander (Spain). Centro Costero de Santander.
For primary bibliographic entry see Field 2L.
W88-05287

**BACTERIAL CONTAMINATION OF SANTANDER BAY (CONTAMINACION BACTERIANA EN LA BAHIA DE SANTANDER),**
Instituto Espanol de Oceanografia, Santander (Spain). Centro Costero de Santander.
I. G. de la Banda, S. Ilardia, and M. J. Porras.
Boletin del Instituto Espanol de Oceanografia, Vol. 3, No. 3, p 41-54, December 1986. 12 fig, 4 tab, 18 ref.

Descriptors: *Bacteria, *Water pollution, *Coastal waters, *Path of pollutants, *Bacterial analysis, Santander Bay, Spain, Coliforms, Streptococcus, Heterotrophic bacteria, Salinity, Hydrogen ion concentration, Dissolved oxygen, Chemical properties.

The results obtained from study of bacterial contamination at six stations placed in Santander Bay and surrounding beaches between November 1978 and October 1980 are reported. The parameters analyzed are bacteriological (fecal coliforms, total coliforms, fecal streptococci and total heterotropha) and physico-chemical (salinity, pH, dissolved oxygen and COD). The bacteriological levels are determined as well as their space-time variations and their relationship with the physico-chemical parameters. At all of the stations tested, there was a correlation between the bacteriological parameters and teh chemical parameters. (Wood-PTT)
W88-05288

**AERIAL SPRAY OF MOSQUITO ADULTICIDES IN A SALT MARSH ENVIRONMENT,**
Harbor Branch Foundation, Inc., Fort Pierce, FL.
T. C. Wang, R. A. Lenahan, J. W. Tucker, and T. Kadlac.
Water Science and Technology WSTED4, Vol. 19, No. 11, p 113-124, 1987. 4 fig, 7 tab, 10 ref.

Descriptors: *Fate of pollutants, *Malathion, *Organophosphorus pesticides, *Insecticides, *Mosquitoes, *Salt marshes, Pesticides, Aquatic insects, Marshes, Estuarine environment, Water quality, Water quality control.

Aerial applications of organophosphorus pesticides are widely used to control adult mosquito populations in Florida. Because the pesticides may drift into estuarine water and affect non-target organisms, a field study was conducted to determine fenthion, malathion, and naled concentrations and disappearance rates in a salt marsh water body. Concentration normally increased and peaked at .75, .95, and 1.40 hrs after an aerial spray for fenthion, naled, and malathion, respectively. The concentration then gradually decreased, and, after 48 hours, only a trace (< or = 0.01 micrograms/l) was detected. (Author's abstract)
W88-05302

**IMPACT OF ABANDONED WELLS,**
Blasband and Bouck Engineers, Syracuse, NY.
For primary bibliographic entry see Field 4C.
W88-05314

**INFLUENCE OF SORPTION PROCESSES ON ALUMINUM DETERMINATIONS IN ACIDIC WATERS,**
University Coll. of Swansea (Wales). Dept. of Chemical Engineering.
X. Goenaga, R. Bryant, and D. J. A. Williams.
Analytical Chemistry ANCHAM, Vol. 69, No. 21, p 2673-2678, November 15, 1987. 2 fig, 7 tab, 36 ref.

Descriptors: *Aluminum, *Path of pollutants, *Acid rain, *Sorption, *Pollutant identification, *Acidic water, Pollutants, Filtration, Membranes, Suspended solids, Adsorption.

Progressive removal of particles from freshwater samples by filtration using various pore diameter polycarbonate capillary membranes (0.4, 0.1, 0.05, and 0.015 micrometers) caused reduction in the levels of labile aluminum (0-23%), as detected with pyrocatechol violet (PCV), in the filtrates. Removal of aluminum adsorbed onto suspended solids and aluminum losses through adsorption onto the membranes are thought to be responsible for these observations. Losses of aluminum during filtration of freshwater samples were evaluated by filtration of particle-free synthetic solutions and found to be <10%. Experiments with a sample of Na-illite showed that aluminum adsorbed theron is partially labile and detectable with PCV in synthetic and natural solutions. It appears that for freshwater samples with high solid surface to aluminum ratios, a significant fraction of the experimentally determined monomeric or inorganic monomeric aluminum may actually be adsorbed aluminum. (Author's abstract)
W88-05315

**EFFECTS OF WASTE DISCHARGES ON MISSISSIPPI RIVER SEDIMENTS,**
Illinois State Water Survey, Peoria.
S. D. Lin, and R. Evans.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 11, p 26-32, November 1987. 4 fig. 7 tab, 15 ref.

Descriptors: *Path of pollutants, *Waste disposal, *Rivers, *Water treatment, *Sediments, Bottom sediments, Mississippi River, East St. Louis, Illinois, Aluminum, Iron, Particle size.

Bottom sediments in the Mississippi River at East St. Louis, Illinois, were studied to determine the effect of discharging water treatment wastes into the river. Average quantities of water treated were 30 mgd by the conventional process and 13.5 mgd by hydrotreators. In this plant the principle sources of waste wer flocculators, settling basins, clarifiers, and filters. The nature of the wastes was characterized as the suspended solids content of the raw water and the aluminum or iron hydroxide generated by coagulation. Average daily solids released from all filters was 4,180 lb. Waste discharges increased the iron, aluminum, moisture, and organics content of the sediments and changed the particle size distribution of the sediments. Changes were observed at three of the 35 sampling stations. The area of influence was about 100 ft offshore and 3,300 ft downstream of the outfall. Within this affected zone iron and aluminum concentrations increased 3.4- and 8-fold above the background concentrations of 2,490 and 760 mg/liter, respectively. During a waste discharge at normal river flow, sediments consisted of 92% sand, 8% gravel, and no silt and clay. However, at low flow silt and clay (34.5%) were found at two protected stations. This derived from the reintroduction of river silt and clay captured during treatment. No unnatural sludge deposit was found within the area of waste discharge influence. No measureable effects from the discharge were found one week after cleaning of the basins. (Cassar-PTT)
W88-05322

**MODELING THE PROPAGATION OF WATERBORNE SUBSTANCES IN DISTRIBUTION NETWORKS,**
Idaho Univ., Moscow. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W88-05328

**ORGANIC CONTAMINATION OF GROUNDWATER: A LEARNING EXPERIENCE,**
Hawaii Univ., Honolulu. Water Resources Research Center.
For primary bibliographic entry see Field 7B.
W88-05336

**ANALYSIS OF BROMACIL, DIURON AND 3,4-DICHLOROANILINE IN CONTAMINATED WELL WATER, USING A HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC COLUMN-SWITCHING PROCEDURE,**
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. for Organic-Analytical Chemistry.
For primary bibliographic entry see Field 5A.
W88-05367

**GEOCHEMICAL ASSOCIATION AND POST-DEPOSITIONAL MOBILITY OF HEAVY METALS IN COASTAL SEDIMENTS: LOCH ETIVE, SCOTLAND,**
Edinburgh Univ. (Scotland). Grant Inst. of Geology.
I. M. Ridgway, and N. B. Price.
Marine Chemistry MRCHBD, Vol. 21, No. 3, p 229-248, September 1987. 7 fig, 4 tab, 57 ref.

Descriptors: *Heavy metals, *Path of pollutants, *Sediments, *Coastal waters, Fate of pollutants, Loch Etive, Scotland, Lead 210, Cesium-137, Iodine, Organic carbon, Sulfates, Copper, Lead, Zinc, Cesium, Sedimentation, Deposition, Enrichment, Distribution, Organic matter, Diagenesis, Metals, Dating, Cesium radioisotopes.

Surficial sediments of a Scottish sea loch exhibit enrichment profiles for the minor metals Cu, Pb, and Zn. Cs137 data indicate enrichment during the last 20-40 years of deposition. Variations in the onset of enrichment between sites within the fjord, which have similar accumulation rates, imply that while the metal inputs may originally have been anthropogenic in nature, the present distribution of the metals in the sediments is controlled by organic matter diagenesis. These processes are especially important within the sulfate-reducing zone. This suggestion is supported by the similar behavior of the heavy metals and Iodine/organic carbon ratios in the sediments. Diagenetic recycling of Pb may also explain discrepancies that were observed between Pb210 and Cs137 chronologies. The source and diagenetic remobilization of these elements is discussed with relation to the fate of anthropogenic metals in coastal sediments. (Author's abstract)
W88-05376

**CHEMICAL CONTAMINANTS MONITORING: PESTICIDE RESIDUES IN LAKE ALBUFERA, VALENCIA, SPAIN,**
Universidad Politecnica de Valencia (Spain). Dept. of Biotechnology.
J. M. Carrasco, M. Planta, V. Gomez-Casals, and V. Moragues.
Journal - Association of Official Analytical Chemists JANCA2, Vol. 70, No. 4, p 752-753, July/August 1987. 4 tab, 7 ref.

Descriptors: *Pollutant identification, *Pesticides, *Monitoring, *Path of pollutants, *Fate of pollutants, *Water pollution effects, *Fish, Herbicides, Insecticides, Pollutants, Water pollution, Valencia, Spain, Lake Albufera, Lakes, Lethal limit, Molinate, Benthiocarb, Fenitrothion, Gas chromatography, Seasonal variation, Weather.

Pesticides used to treat both the crops and the forest surrounding Lake Albufera in Valencia, Spain, might migrate into the lake and contaminate it. The contamination is most likely to occur when water from rice fields which were treated with weed killers according to recently introduced agricultural practices drains into the lake. In order to determine the actual hazards associated with the pesticide treatment, the levels of the two commonly used weed killers, molinate and benthiocarb, and the insecticide fenitrothion were determined. Three samples were taken at each of nine sites distributed around the perimeter and in the middle of the lake were analyzed by gas chromatography. The coefficients of variation were minor at 10% and the recoveries were 80-90%. Of the pesticides studied, only molinate reached significant levels in the lake's waters; seasonal variations were noted. The maximum levels of pesticides were found at the outfall of several channels, in the area of deposition of the waterborne compounds. Weather conditions affected both the levels and duration of contamination. The water analyses indicated that none of the three pesticides studied reached levels lethal to fish in the lake itself, although fish occasionally died in the rice fields or in the channels that drain the fields. (Wood-PTT)
W88-05393

**MATHEMATICAL MODELING OF SOLUTE TRANSPORT IN THE SUBSURFACE,**
Battelle Memorial Inst., Columbus, OH. Environmental and Health Sciences Section.
T. G. Naymik.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 17, No. 3, p 229-251, 1987. 1 fig, 112 ref.

Descriptors: *Reviews, *Model studies, *Solute transport, *Path of pollutants, *Advection, *Groundwater movement, Mathematical studies, Prediction, Geohydrology.

A review of key works on solute transport models indicates that solute transport processes with the exception of advection are still poorly understood. Solute transport models generally do a good job when they are used to test scientific concepts and hypotheses, investigate natural processes, systematically store and manage data, and simulate mass balance of solutes under certain natural conditions. Solute transport models generally are not good for predicting future conditions with a high degree of certainty, or for determining concentrations precisely. The mathematical treatment of solute transport far surpasses our understanding of the process. Investigations of the extent of groundwater contamination and methods to remedy existing problems show the along-term nature of the hazard. Industrial organic compounds may be immiscible in water, highly volatile, or complexed with inorganic as well as other organic compounds; many remain stable in nature almost indefinitely. Through modeling technology, clean-up strategies can be optimized, or, at the least, alternatives can be simulated, thus providing a basis for determining cost effectiveness. In the worst case, future

disposal of hazardous waste may be restricted to deep burial, as is proposed for radioactive wastes. For investigations pertinent to transport of radionuclides from a geologic repository, the process cannot be fully understood without adequate thermodynamic and kinetic data bases. Empirical data are largely unavailable for temperatures above 25 deg C and 1 bar pressure although, in some cases, sufficiently accurate estimates can be made. From a standpoint of demonstrating regulatory compliance, understanding of the numerous coupled and uncoupled geochemical processes must be greatly improved before a high degree of confidence can be placed in this type of test. The uncertainties in the hydrogeological parameters affecting contaminant transport, the spatial variability of natural geologic systems, and the ability to predict with confidence the future migration of contaminants must be factored into the hydrogeologist's analysis of solute transport at specific sites. (Alexander-PTT)
W88-05425

**GROUNDWATER CONTAMINATION BY TEMIK ALDICARB PESTICIDE: THE FIRST 8 MONTHS,**
Harvard School of Public Health, Boston, MA. Interdisciplinary Programs in Health.
For primary bibliographic entry see Field 5G.
W88-05432

**EFFECTS OF ACIDIC DEPOSITION ON THE CHEMISTRY OF HEADWATER STREAMS: A COMPARISON BETWEEN HUBBARD BROOK, NEW HAMPSHIRE, AND JAMIESON CREEK, BRITISH COLUMBIA,**
Syracuse Univ., NY. Dept. of Civil Engineering.
C. T. Driscoll, N. M. Johnson, G. E. Likens, and M. C. Feller.
Water Resources Research WRERAO, Vol. 24, No. 2, p 195-200, February 1988. 3 fig, 2 tab, 35 ref.

Descriptors: *Acid rain, *Water pollution sources, *Acidic deposition, *Water chemistry, *Headwaters, *Streams, *Watersheds, *Aluminum, Acids, Acidity, Speciation, Neutralization, Cations.

Streamwater samples were collected from watersheds in Jamieson Creek, British Columbia, and the Hubbard Brook Experimental Forest, New Hampshire, to compare the chemistry of drainage waters which are unimpacted and impacted by acidic deposition. Qualitative and quantitative differences in the chemistry of headwater streams were evident. Principal among these were a shift from acidification by organic acids to strong acids, increased concentrations of aqueous Al, and a change in Al speciation from largely organic to inorganic forms. In both watersheds, streamwater acidity is ultimately neutralized by the release of basic cations. (Author's abstract)
W88-05433

**MODELING SOLUTE SEGREGATION DURING FREEZING OF PEATLAND WATERS,**
Michigan Univ., Ann Arbor. Dept. of Chemical Engineering.
R. H. Kadlec, X.-M. Li, and G. B. Cotten.
Water Resources Research WRERAO, Vol. 24, No. 2, p 219-224, February 1988. 4 fig, 20 ref.

Descriptors: *Path of pollutants, *Freezing, *Peatlands, *Solute transport, *Geochemistry, *Model studies, Top soil, Pore water, Algorithms, Mathematical equations, Prediction, Ice.

Freezing of the shallow water in a peatland causes the downward movement of solutes. Field and laboratory data demonstrate that a considerable portion of the solutes are driven into the topsoil from the overlying water by freezing. Such solute redistribution phenomena in peatlands are of interest for establishing the geochronology of deposits and determining the nature of pollutant burial. A mathematical model has been developed to described the solute segregation processes at the freezing front in both overlying water and interstitial water in the porous peat and solute transport in the unfrozen water. An algorithm has been developed to solve this nonlinear moving interface problem. The solute concentrations in ice and water phases are reproduced by the model. Computer simulation results provide good predictions of independent experimental data. (Author's abstract)
W88-05436

**FURTHER COMMENTS ON SENSITIVITIES, PARAMETER ESTIMATION, AND SAMPLING DESIGN IN ONE-DIMENSIONAL ANALYSIS OF SOLUTE TRANSPORT IN POROUS MEDIA,**
Geological Survey, Reston, VA.
D. S. Knopman, and C. I. Voss.
Water Resources Research WRERAO, Vol. 24, No. 2, p 225-238, February 1988. 12 fig, 7 tab, 34 ref, append.

Descriptors: *Model studies, *Groundwater movement, *Solute transport, *Porous media, *Path of pollutants, *Sensitivity analysis, Mathematical equations, Solutes, Estimating, Spatial variability.

Sensitivities of solute concentration to parameters associated with first-order chemical decay, boundary conditions, initial conditions, and multilayer transport were examined in one-dimensional analytical models of transient solute transport in porous media. A sensitivity is a change in solute concentration resulting from a change in a model parameter. Sensitivity analysis is important because minimum information required in regression on chemical data for the estimation of model parameters by regression is expressed in terms of sensitivities. Nonlinear regression models of solute transport were tested on sets of noiseless observations from known models that exceeded the minimum sensitivity information requirements. Results demonstrate that the regression models consistently converged to the correct parameters when the initial sets of parameter values substantially deviated from the correct parameters. On the basis of the sensitivity analysis, several statements may be made about design of sampling for parameter estimation for the models examined: (1) estimation of parameters associated with solute transport in the individual layers of a multilayer system is possible even when solute concentrations in the individual layers are mixed in an observation well; (2) when estimating parameters in a decaying upstream boundary condition, observations are best made late in the passage of the front near a time chosen by adding the inverse of an hypothesized value of the source decay parameter to the estimated mean travel time at a given downstream location; (3) estimation of a first-order chemical decay parameter requires observations to be made late in the passage of the front, preferably near a location corresponding to a travel time of square root of 2 times the half-life of the solute; and (4) estimation of a parameter relating to spatial variability in an initial condition requires observations to be made early in time relative to passage of the solute front. (Author's abstract)
W88-05437

**FLUID MECHANICS OF FRACTURE AND OTHER JUNCTIONS,**
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
J. R. Philip.
Water Resources Research WRERAO, Vol. 24, No. 2, p 239-246, February 1988. 11 fig, 1 tab, 7 ref, append.

Descriptors: *Groundwater movement, *Hydrodynamics, *Solute transport, *Path of pollutants, *Geologic fractures, *Fluid mechanics, *Model studies, Flow, Mathematical studies, Porous media, Solutes, Transport.

In connection with solute transfer in fracture networks, Hull and Koslow proposed proportional routing of streamlines through discontinuous fracture junctions (in which inlet and outlet branches alternate). The application of fluid mechanics to the problem showed that the errors of proportional routing may be unacceptably large when the two inlet discharges and the two outlet discharges both differ greatly in magnitude. In extreme cases one inlet flow is wholly excluded from one of the two outlets, and proportional routing is maximally incorrect. Solutions are established for arbitrary discharge patterns through four-way coplanar junctions: exact solutions for Laplace flows (Hele-Shaw flows and Darcy flows, fractures filled with porous material) and approximate solutions for Stokes flows. The Laplace solutions apply also to a range of transport processes. (Author's abstract)
W88-05438

**HYDROLOGIC DETECTION OF ABANDONED WELLS NEAR PROPOSED INJECTION WELLS FOR HAZARDOUS WASTE DISPOSAL,**
Lawrence Berkeley Lab., CA. Earth Sciences Div.
For primary bibliographic entry see Field 5E.
W88-05440

**NUMERICAL ANALYSIS OF THE NONSTEADY TRANSPORT OF INTERACTING SOLUTES THROUGH UNSATURATED SOIL 1. HOMOGENEOUS SYSTEMS,**
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Dept. of Soil Physics
D. Russo.
Water Resources Research WRERAO, Vol. 24, No. 2, p 271-284, February 1988. 12 fig, 5 tab, 36 ref, append.

Descriptors: *Infiltration, *Path of pollutants, *Solute transport, *Unsaturated soils, *Model studies, *Soil water, Anions, Cations, Hydraulic conductivity, Soil properties, Solutes, Spatial variation.

Transient one-dimensional vertical transport of mixed Na/Ca solutions in a saturated-unsaturated homogeneous soil during infiltration was studied using a modified version of the transport model of Breslet, taking into account physiocochemical interactions between the soil solution and the soil matrix expressed in terms of changes in the hydraulic conductivity and retentivity functions, anion exclusion, and cation exchange. The anion-cation factors were derived from theoretical considerations based on the mixed ion diffuse double-layer theory, the structure of the clay particles, the pore size distribution of the soil, and hydrodynamic principles. The solute transport was analyzed for three soils of different textures and for different sets of boundary and initial conditions. Results of the analyses suggest that the effect of soil-matrix-soil-solution interactions on the transport of water and solutes may be significant and generally increases as the wetting zone soil water content and soil solution sodium adsorption ratio increase, as its solute concentration decreases, as the clay fraction of the soil increases; and as the soil texture becomes finer. For a given soil the magnitude of these interactions and their effect on the transport process are affected by the surface boundary conditions and the initial conditions. For a given set of boundary and initial conditions the retardation of the water and solute movement due to the soil-solution-soil-matrix interactions, relative to a reference inert state, depends on the soil texture. (See also W88-05442) (Author's abstract)
W88-05441

**NUMERICAL ANALYSIS OF THE NONSTEADY TRANSPORT OF INTERACTING SOLUTES THROUGH UNSATURATED SOIL 2. LAYERED SYSTEMS,**
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Dept. of Soil Physics
D. Russo.
Water Resources Research WRERAO, Vol. 24, No. 2, p 285-290, February 1988. 4 fig, 2 tab, 13 ref.

Descriptors: *Infiltration, *Soil water, *Irrigation, *Sodium adsorption ratio, *Path of pollutants, *Solute transport, *Unsaturated soils, *Model studies, Anions, Cations, Hydraulic conductivity, Soil properties, Solutes, Soil water, Spatial variation.

Transient one-dimensional vertical transport of interacting solutes through a saturated-unsaturated stratified soil profile during infiltration was studied using a modified version of a previously described transport model taking into account the depth variations of the coupling interacting soil input parameters. The solute transport was analyzed for two sequences of soil layering: a fine-textured soil overlying coarser textured soils and a coarse-textured soil overlying finer textured soils. Each sequence was analyzed for two different initial conditions and a given surface boundary condition pertinent to a common irrigation practice using nonsaline water. Results of the analyses suggest that the effect of soil-matrix-soil-solution interactions on the transport of water and solutes may be significant and generally depends on the sequence of the soil layering and on the shape of the initial soil solutions's sodium adsorption ratio (SAR) profile. For a given initial soil solution's SAR profile the effect of soil-solution-soil-matrix interactions on the transport process is greater when a fine-textured soil is overlying coarser textured soils. For a given sequence of layering the movement of the interacting solutes may be retarded or accelerated relative to a reference inert state, depending on the shape of the initial soil solution's SAR profile relative to the sequence of the layering. On a field scale, the effect of the soil-solution-soil-matrix interactions on the transport process may increase the spatial variability of the water and the solute in a cross-sectional area of the field. (See also W88-05441) (Alexander-PTT)
W88-05442

**EXAMINATION AND CHARACTERIZATION OF DISTRIBUTION SYSTEM BIOFILMS,**
American Water Works Service Co., Inc., Belleville, IL. Belleville Lab.
For primary bibliographic entry see Field 5F.
W88-05446

**ENUMERATION OF VIBRIO CHOLERAE O1 IN BANGLADESH WATERS BY FLUORESCENT-ANTIBODY DIRECT VIABLE COUNT,**
Maryland Univ., College Park. Dept. of Microbiology.
For primary bibliographic entry see Field 5A.
W88-05449

**TRENDS OF ORGANOCHLORINE RESIDUES IN EGGS OF BIRDS FROM ITALY, 1977 TO 1985,**
Pavia Univ. (Italy). Dipt. Biologia Animale.
M. Fasola, and I. Vecchio.
Environmental Pollution EPEBD7, Vol. 48, No. 1, p 25-36, 1987. 2 fig, 3 tab, 28 ref.

Descriptors: *Path of pollutants, *Water pollution effects, *Birds, *Eggs, *Pesticides, *Organochlorine compounds, Insecticides, Aquatic habitats, Habitats, Food habits, Fish, Trophic level, Water birds, Terns, Herons, Gulls, Polychlorinated biphenyls, DDE, DDT, TDE, Aldrin, Dieldrin, Endrin, Lindane, Heptachlor, Sparrows, Crows, Italy.

Organochlorines in eggs collected from ten bird species in Italy in 1982 and 1983 are reported as part of a study of pesticide residues started in 1977. DDE and other organochlorine contaminants were found in eggs from three gulls, four terns, the night heron, the hooded crow, and the tree sparrow. However, DDE concentrations showed a decreasing trend from 1978 to 1985 in several species. Insecticides included in the analysis were DDE, TDE, aldrin, dieldrin, endrin, lindane, and heptachlor. DDE levels (expressed as micrograms/gram fresh weight) in 1982 and 1983 were as follows: gulls, 0.10-0.28; terns, 0.28-0.84; night heron, 0.82; hooded crow, 0.18; and tree sparrow, 0.26. Feeding habits were correlated with DDE concentrations, highest levels being found in the night herons and terns, which feed on aquatic animals, lower levels in the omnivorous gulls, and lowest levels in the terrestrial crow and sparrow. Eggshell thickness was not adversely affected. However, in the night heron a slight reduction in eggshell thickness was related to DDE concentration. The study results indicated that the current impact of organochlorines on these birds is probably negligible. (Cassar-PTT)
W88-05455

**BACTERIAL BIOABSORPTION OF NICKEL FROM INDUSTRIAL COOLING WATER,**
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Microbiology.
H. C. Kasan, and P. Stegmann.
Environmental Pollution EPEBD7, Vol. 48, No. 4, p 311-319, 1987. 4 fig, 25 ref.

Descriptors: *Path of pollutants, *Water pollution effects, *Water reuse, *Nickel, *Cooling water, *Bacteria, *Heavy metals, Metals, Accumulation, Absorption, Microbiological studies, Adaptation, Toxicity, Inhibitors, Bacterial physiology.

Three bacterial strains tolerant to 100 mg/liter of nickel ions were isolated from samples of industrial cooling water. The percentage of nickel as a fraction of the total available in broth (100 mg/liter) accumulated by each strain was 18, 7, and 20. The strain which showed the highest ability to concentrate nickel was identified as an Enterobacter sp. Further studies using this bacterial strain showed that growth and glucose utilization were inhibited by the presence of nickel. Maximum biomass production was attained after 8 days in the absence of nickel and in 19 days in the presence of 100 mg Ni/liter. Intracellular nickel deposition was revealed by energy dispersive X-ray analysis and transmission electron microscopy. (Cassar-PTT)
W88-05464

**THEORY ON THE MECHANISMS REGULATING THE BIOAVAILABILITY OF MERCURY IN NATURAL WATERS,**
Bohlin and Stromberg A.B., Solna (Sweden).
A. Bjornberg, L. Hakanson, and K. Lundbergh.
Environmental Pollution EPEBD7, Vol. 49, No. 1, p 53-61, 1988. 2 fig, 24 ref.

Descriptors: *Path of pollutants, *Chemical reactions, *Mercury, *Bioavailability, *Equilibrium, *Heavy metals, Metals, Sulfides, Tellurium, Selenium, Fish, Oxidation-reduction potential.

A theory proposed to explain the mercury content in fish is that the activity of Hg(++) in natural waters is essentially regulated by the activity of sulfide ion, which, in turn, is strongly affected by pH and redox conditions. At natural pH levels sulfide ion activity is very low. In the presence of sulfide essentially all Hg will appear as HgS(s). The Hg(++) activity and the Hg content in fish can be increased if the sulfide ion activity is decreased by lowering the pH and/or increasing the redox potential. Selenium and tellurium have similar relationships with Hg. The Hg(++) concentration in natural waters varies widely but is often about 5 ng/liter. This is considered a high concentration in this context, and it can only prevail if the sulfide ion and/or selenium ion activity is very small. In waters where sulfide ion and/or selenium ion activity is high (e.g., sulfide rocks in the drainage area) the Hg(++) activity and the Hg(++) content of fish is effectively reduced. (Cassar-PTT)
W88-05466

**EXPERIMENTAL MEASUREMENTS AND COMPUTER PREDICTIONS OF COPPER COMPLEX FORMATION BY SOLUBLE SOIL ORGANIC MATTER,**
Rothamsted Experimental Station, Harpenden (England). Dept. of Soils and Plant Nutrition.
J. R. Sanders, and S. P. McGrath.
Environmental Pollution EPEBD7, Vol. 49, No. 1, p 63-76, 1988. 2 fig, 6 tab, 19 ref.

Descriptors: *Path of pollutants, *Chemical reactions, *Copper, *Organic matter, *Chelation, *Heavy metals, Metals, Soil chemistry, Trace metals, Computer programs, Clays, Loams, Hydrogen ion concentration.

The extent of copper complex formation by soluble organic matter extracted from an organic soil, a clay, and two sandy loams was measured by two independent methods: ion exchange equilibrium and spectrometry. The results fitted equations similar to Langmuir two-surface isotherms, but the values of complexing capacity and complexing strength were not the same for the organic matter from the four soils. Therefore these values were not suitable for use in computer programs designed to predict concentrations of individual copper species in soil solutions. However, the approximate extent of complex formation can be predicted if the pH and the total copper and soluble organic matter concentrations (in molar units) are known, using an empirical relationship between free and total copper. The relationship holds for a representative selection of soil solutions under identical conditions of pH and ionic strength. (Cassar-PTT)
W88-05467

**MICROORGANISMS IN MUNICIPAL SOLID WASTE AND PUBLIC HEALTH IMPLICATIONS,**
Environmental Protection Agency, Cincinnati, OH. Hazardous Waste Engineering Research Lab.
H. R. Pahren.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 17, No. 3, p 187-228, 1987. 16 tab, 148 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Water pollution sources, *Water pollution effects, *Literature review, *Wastewater treatment, *Solid wastes, *Landfills, *Public health, *Microorganisms, Waste disposal, Viruses, Bacteria, Leachates, Feces, Coliforms, Enteric bacteria, Enteroviruses, Pathogens, Risks, Incineration, Composting, Sludge, Aerosols, Land disposal, Wastewater disposal, Spray irrigation, Diseases.

Municipal solid waste is a heterogeneous mixture of materials from industrial, institutional, commercial, and household sources. As a result, densities of microorganisms are relatively high, with paper products (diapers, used tissues, and pet feces wrapped in paper) and garden wastes responsible for substantial portions of the total. Microorganism densities in landfills remain high for many years; some of the microorganisms are associated with decay processes, but some pathogens are also present. Leachates provide a harsh environment for microorganism survival; very few microbes are transported by leachates after the waste has been in place for a few months. A risk assessment for ingestion of groundwater near a hypothetical sludge showed that to contract salmonellosis, 880 gal of water would have to be consumed; 400 gal, for an enterovirus infection. Composting can inactivate most of the microorganisms associated with fecal matter. Wastewater handling in treatment plants has potential for adverse health effects, particularly from aerosols containing microorganisms, but the few studies on this subject show little evidence of disease transmission in the plants. Spraying of partially treated wastewater or digested sewage sludge on agricultural land generates aerosols containing microorganisms, but apparently there is a rapid die-off after the microorganisms reach the aerosol form. Enteroviruses were recovered from wastewater used for irrigation in Michigan, but not from the aerosols sampled while spraying. (Cassar-PTT)
W88-05469

**TRACE METAL INTERACTIONS WITH MICROBIAL BIOFILMS IN NATURAL AND ENGINEERED SYSTEMS,**
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W88-05470

**MODELING MICROBIAL FATE IN THE SUBSURFACE ENVIRONMENT,**
Robert S. Kerr Environmental Research Lab., Ada, OK. Subsurface Processes Branch.
M. V. Yates, and S. R. Yates.
CRC Critical Reviews in Environmental Science CCECAU, Vol. 17, No. 4, p 307-344, 1988. 8 tab, 223 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Water pollution sources, *Literature review, *Microorganisms, *Groundwater pollution, Bacteria, Viruses, Absorption, Public health, Model studies, Mathematical models, Diseases, Soil properties, Organic matter, Hydraulics, Temperature, Hydrogen ion concentration, adsorption, Filtration.

Knowledge of the transport of bacteria and viruses is important in preventing disease from groundwater contamination. These organisms may be introduced into the subsurface environment by wastewater irrigation, landfill leachates, and septic tank effluent. Conditions favoring the survival and transport of bacteria are (1) low temperature, (2) absence of other types of bacteria, (3) moisture in soils, (4) neutral or slightly alkaline pH, (5) absence of certain cations (Ca(++), Mg(++), and Na+), (6) large pore size soils, (7) bacterial characteristics (spore formation, larger size), (8) nutrients provided by organic matter, (9) absence of biological mats as found in septic system fields, (10) high hydraulic loading rates. Conditions favoring the survival and transport of viruses are (1) low temperature, (2) absence of other microorganisms, (3) moisture in soils, (4) presence of very low concentrations (<0.01M) Ca(++) or Ba(++), (5) lack of virus aggregation, (6) coarse-textured soil, (7) high hydraulic loading rates. The influences of pH, soil adsorption, virus type, and organic matter on viral inactivation and transport are more variable. Models for describing the fate of microorganisms are reviewed. More models concern viruses because, in general, viruses survive longer and travel further than bacteria. (Cassar-PTT)
W88-05471

**PINPOINTING NONPOINT POLLUTION,**
Tennessee Valley Authority, Chattanooga. Mapping Services Branch.
F. R. Perchalski and, and J. M. Higgins.
Civil Engineering CEWRA9, Vol. 58, No. 2, p 62-64, February 1988.

Descriptors: *Aerial photography, *Infrared imagery, *Remote sensing, *Nonpoint pollution sources, *Livestock, *Mapping, *Maps, Data processing, Economic aspects.

The Tennessee Valley Authority has employed aerial photography to map its attack on nonpoint sources of water pollution. These sources cause most of the water quality problems in the region and, unlike point sources, are difficult to locate and monitor by conventional methods. In one test, analysis of large scale aerial photographs provided the information needed to define the pollution sources and target cleanup efforts. Infrared color, stereoscopic photos at a scale of 1:24,000, revealed 226 livestock operations and their surface drainage connections in a 70,000 acre watershed. Controlling nonpoint sources of water pollution will require a long term commitment. But at a cost of pennies per acre, aerial photographic methods provide an essential complement to conventional data collection techniques. (VerNooy-PTT)
W88-05473

**SPREADING OF OIL ON WATER IN THE SURFACE-TENSION REGIME,**
Washington Univ., Seattle. Dept. of Chemical Engineering.
D. W. Camp, and J. C. Berg.
Journal of Fluid Mechanics JFLSA7, Vol. 184, p 445-462, November 1987. 16 fig, 2 tab, 14 ref. National Science Foundation Grant MEA 8109226.

Descriptors: *Path of pollutants, *Oil-water interfaces, *Oil, *Surface tension, *Surfactants, *Mathematical analysis, *Mathematical models, Fatty acids, Alcohols, Films.

Data were collected to describe the unidirectional spreading of several pure oils and oil-surfactant mixtures on water in the surface-tension regime. Leading-edge position and profiles of velocity, thickness and film tension are given as functions of time. The data are consistent with the numerical similarity solution of Foda & Cox although the measured dependence of the film tension on the film thickness often differs from the equilibrium relationship. The configuration of the oil film near the spreading origin may be either a coherent multimolecular layer or a multitude of thinning, outward-moving lenses surrounded by monolayer. The pure oils show an acceleration zone connecting the slow-moving inner region to a fast-moving outer region, while the oil-surfactant mixtures show a much more gradual increase in film velocity. (Author's abstract)
W88-05474

**CLEANUP ON A LARGE SCALE,**
CH2M Hill, Newport Beach, CA. Southern California Regional Office.
For primary bibliographic entry see Field 5G.
W88-05476

**DETECTING UNDERGROUND PIPING LEAKS,**
Groundwater Technology, Inc., Annapolis Junction, MD.
For primary bibliographic entry see Field 5A.
W88-05478

**LOCAL CHANGES OF SALINITY AND NUTRIENTS AND PROCESSES CONTRIBUTING TO THE NUTRIENT DISTRIBUTION OFF THE EVROS RIVER, IN THE NORTH AEGEAN SEA,**
Institute of Oceanographic and Fisheries Research, Athens (Greece).
N. Friligos.
Toxicological and Environmental Chemistry TXECBP, Vol. 16, No. 1, p 1-16, 1987. 5 fig, 4 tab, 36 ref.

Descriptors: *Path of pollutants, *Nutrients, *Salinity, *Coastal waters, Distribution patterns, North Aegean Sea, Fate of pollutants, Limiting nutrients, Silicates, Nitrogen compounds, Ammonia, Nitrites, Phosphates, Evros River, Plumes, Spatial distribution, Temporal distribution, River mouth, Correlation analysis.

The distribution of salinity, silicate, ammonia, nitrite, and phosphate off the Alexandroupolis coast, both inside and outside the Evros River plume, were observed during three cruises between March 1981 and March 1982. The most important river source of nutrients is the Evros River and the data show that there is a large spatial and temporal variability of salinity and nutrients during both high and low discharge periods. The extension of the area influenced by the river mouth is characterized by a highly significant correlation between salinity and nutrients. This indicates a control of the dynamics of the nutrients by the physical processes of dilution. In the second zone, lying further from the river mouth, this correlation is lost because of the superposition of biological factors. The fact that in some zones the concentration of the total inorganic nitrogen was sometimes found to be undetectable, suggests that nitrogen could be the growth limiting factor. (Author's abstract)
W88-05495

**RAPID STATISTICAL CORRELATION BETWEEN POLLUTION SOURCES AND MARINE CONCENTRATIONS,**
Bulgarian Academy of Sciences, Varna. Inst. of Oceanography.
G. Andreev, and V. Simeonov.
Toxicological and Environmental Chemistry TXECBP, Vol. 16, No. 1, p 69-73, 1987. 2 fig, 16 ref.

Descriptors: *Water pollution sources, *Pollutant concentrations, *Fate of pollutants, *Path of pollutants, *Statistical analysis, *Heavy metals, Pollutants, Estimating, Distribution patterns, Distribution graphs, Correlation analysis, Mathematical studies, Correlation coefficient, Marine environment, Hydrogen ion concentration, Ammonia, Phosphates, Iron, Copper, Lead, Cadmium, Zinc, Mercury.

An easy approach is suggested for the rapid estimation of the connection between concentration of inorganic pollutants in marine environments and the distance from the potential polluting source. The construction of distribution graphs of the calculated correlation coefficients for different polluting species, including fluoride, pH, ammonia, phosphate, iron, copper, lead, cadmium, zinc, and mercury, provided a connection between pollution factors (concentration of pollutants) and possible anthropogenic activities (distance from the coast). The method allowed determination of the region of influence of a given polluting source or group of sources. The correlation analysis is based on a substantial data set over a long period of time. (Wood-PTT)
W88-05496

**DISULFATE ION AS AN INTERMEDIATE TO SULFURIC ACID IN ACID RAIN FORMATION,**
Lawrence Berkeley Lab., CA. Applied Science Div.
S. G. Chang, D. Littlejohn, and K. Y. Hu.
Science SCIEAS, Vol. 237, No. 4816, p 756-758, August 14, 1987. 3 fig, 1 tab, 8 ref. DOE Contract DE-AC03-76SF00098.

Descriptors: *Chemical reactions, *Reaction intermediates, *Sulfuric acid, *Acid rain, *Water pollution, Disulfate ions, Anions, Ions, Raman spectroscopy, Oxidation.

The oxidation of the bisulfite ion by dissolved oxygen to produce sulfate ion involves the formation of a previously undetected intermediate. This intermediate has a fairly strong Raman band at 1090 wave numbers and a weak Raman band at 740 wave numbers, both of which are probably due to sulfur-oxygen stretches. The intermediate is proposed to be the disulfate ion S2O7(2-), which hydrolyzes into H(+) and either SO4(2-) or HSO4(-) with a half-life of about 52 seconds at 25 degrees C. (Author's abstract)
W88-05502

**BIOGENIC SULFUR AND THE ACIDITY OF RAINFALL IN REMOTE AREAS OF CANADA,**
National Water Research Inst., Burlington (Ontario).
J. O. Nriagu, D. A. Holdway, and R. D. Coker.
Science SCIEAS, Vol. 237, No. 4819, p 1189-1192, September 4, 1987. 2 fig, 1 tab, 29 ref.

Descriptors: *Acid rain, *Water pollution sources, *Rainfall, *Wetlands, *Air pollution, *Isotopic tracers, *Path of pollutants, Sulfur, Canada, Isotopic tracers, Remote areas, Acidity, Precipitation.

Sulfur released from any given natural or anthropogenic source carries an isotopic signature that can be used to trace its flow through the environment. Measurements of the concentration and isotopic composition of sulfur in weekly bulk precipitation samples collected over a 4-year period at a remote location in northern Ontario were recorded. The long-term isotopic data and the measurement on the production and release of dimethyl sulfide from boreal wetlands show that biogenic sources can account for up to 30 percent of the acidifying sulfur burden in the atmosphere in remote areas of Canada. The data suggest that significant biological reemission of anthropogenic sulfur is occurring. The role of this process in the continuing acidification of the environment for years to come must be a matter of concern. (Author's abstract)
W88-05503

**CHEMISTRY AND FATE OF AL(III) IN TREATED DRINKING WATER,**
Syracuse Univ., NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W88-05508

**STOCHASTIC DISSOLVED OXYGEN MODEL,**
Gore and Storrie Ltd., Toronto (Ontario). Water Resources Div.
P. A. Zielinski.
Journal of Environmental Engineering (ASCE)

JOEDDU, Vol. 114, No. 1, p 74-90, February 1988. 8 fig, 2 tab, 9 ref, 3 append.

Descriptors: *Water quality, *Rivers, *Mathematical models, *Model studies, *Dissolved oxygen, *Biochemical oxygen demand, *Nitrogen oxygen demand, *Photosynthesis, Model testing, Thames River, Ontario, Differential equations, Moment equations, Mathematical equations, Mathematical studies, Computers, River basins, Planning.

A one-dimensional steady state stochastic river water quality model is developed to compute the mean values and standard deviations of carbonaceous biochemical oxygen demand, DO and nitrogen oxygen demand concentrations at any point in a river. The model considers randomness in the initial conditions, inputs, rate constants and other model parameters as well as randomness in each of the modeled processes themselves. The stochastic characteristics are determined by analytically solving the moment equations associated with Ito stochastic differential equations. The solution is obtained for a diurnally varied photosynthetic component. The resulting equations are readily solved on microcomputers and consequently can be used effectively in an interactive model for river basin planning. A demonstration application for the Thames River in Ontario is presented. (Author's abstract)
W88-05511

**STUDY OF RIVER REAERATION AT DIFFERENT FLOW RATES,**
Ministry of Works and Development, Hamilton (New Zealand). Water Quality Centre.
R. J. Wilcock.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 91-105, February 1988. 3 fig, 6 tab, 32 ref.

Descriptors: *Reaeration, *Fate of pollutants, *River flow, *Rivers, *Model studies, *Aeration, Flow rates, Tarawera River, New Zealand, Waste disposal, Wastewater treatment, Industrial wastes, Pulp wastes, Mathematical studies, Mathematical equations, Mathematical models, Tracers.

The lower Tarawera River in New Zealand is a fast-flowing, turbulent water body that is used for the disposal of wood-pulp mill wastes. A number of gas tracer experiments are carried out to measure the reaeration coefficient, K sub 2, at different flow rates. The magnitudes of the results are best described by energy dissipation models, which relate K sub 2 to the rate of change of hydraulic head. It has been demonstrated elsewhere that such models are better able to describe reaeration in turbulent waters having appreciable surface disruption, such as the Tarawera River, than are surface renewal models. The results show that K sub 2 decreases slightly, but significantly, as flow rate increases and that this trend is better described by a surface renewal model than by energy dissipation models. The trend with flow is incorporated into the energy dissipation model by using nonlinear regression to develop an expression for C, the escape coefficient, that is a function of the flow rate. (Author's abstract)
W88-05512

**EFFECTS OF STREAMFLOW VARIATION ON CRITICAL WATER QUALITY FOR MULTIPLE DISCHARGES OF DECAYING POLLUTANTS,**
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
J. W. Eheart.
Water Resources Research WRERAO, Vol. 24, No. 1, p 1-8, January 1988. 3 fig, 2 tab, 11 ref, append. USEPA Cooperative Agreements CR-812577-01 and CR-812577-02.

Descriptors: *Water quality, *Path of pollutants, *Fate of pollutants, *Streamflow, *Multiple pollutant discharges, *Streams, Dissolved oxygen, Mathematical equations, Mathematical studies, Pollutants, Isotherms, Uniform flow, Hydraulic geometry.

The assumption that the worst water quality occurs at the lowest streamflow may not always hold in instances involving multiple discharges and nonconservative pollutants. The additional dilution resulting from increased streamflow may be offset by adverse changes in the parameters that govern water quality and in decreased residence time, which allows the stream less time to recover from the effect of one discharge before receiving another. The question of whether, with multiple sources of decaying pollutants, water quality might worsen with increasing streamflow was investigated. For an isothermal uniform stream it is shown that the pattern of discharge that maximizes the derivative with respect to streamflow of critical dissolved oxygen deficit or the concentration of a substance exhibiting a first-order decay is an infinite uniform distributed load. Whether the maximum value of the derivative is positive or negative depends on the values of the parameters that characterize the hydraulic geometry of the channel and the dependence of reaeration on flow. Theoretical results presented indicate that for most natural streams the traditional assumption, that the lowest streamflow is the worst from a water quality perspective, will usually be valid for first-order pollutants. Nevertheless, they also lead to the expectation that increases in impacts with increasing streamflow might occur for dissolved oxygen, especially in highly polluted and regulated streams. (Author's abstract)
W88-05524

**ANALYSIS OF EVENT-BASED PRECIPITATION DATA WITH A VIEW TOWARD MODELING,**
Washington Univ., Seattle. Dept. of Statistics.
P. Guttorp.
Water Resources Research WRERAO, Vol. 24, No. 1, p 35-43, January 1988. 4 fig, 38 ref, append.

Descriptors: *Precipitation, *Rainfall, *Data interpretation, *Model studies, *Stochastic process, *Acid rain, *Path of pollutants, Storms, Mathematical models, Mathematical equations, Mathematical studies, Precipitation amounts, Poisson ratio.

Using data from two stations in the Multistate Atmospheric Power Product Pollution Study (MAP3S) acid precipitation monitoring network, some aspects of the marked point process of rainfall events are investigated and are used to illustrate some potentially useful data analytic techniques. No statistically significant evidence was found against a Poisson process model of storm arrivals, observed with a dead time corresponding to event duration. In particular, the relation between amounts and the history of the process of events and the relation between events at two different stations were investigated. Events that occur close to previous events tend to have smaller than average precipitation amounts. Some implications for parametric models of precipitation processes are discussed. (Author's abstract)
W88-05528

**MULTICOMPONENT EXCHANGE AND SUBSURFACE SOLUTE TRANSPORT: CHARACTERISTICS, COHERENCE, AND THE RIEMANN PROBLEM,**
Texas Univ. at Austin. Dept. of Civil Engineering.
R. J. Charbeneau.
Water Resources Research WRERAO, Vol. 24, No. 1, p 57-64, January 1988. 6 fig, 29 ref, append.

Descriptors: *Groundwater movement, *Solute transport, *Subsurface water, *Hydraulics, *Ion exchange, Riemann problem, Flow, Effluents, Mathematical equations, Mathematical studies, Observation wells, Mathematical models, Model studies, Method of Characteristics, Well data.

When water of one chemical composition is displaced by water of another, there is a change in composition at any point within the flow system which may occur more or less rapidly, depending on both the hydraulics and chemistry of the system. For many applications it is possible to decouple the hydraulic and chemical analyses, and later combine them for prediction of effluent compositions from well fields or concentration histories at observation wells. When an advection-reaction model is used, the displacement problem is described mathematically as a Riemann problem. The Riemann problem is solved for the ternary exchange system using the method of characteristics. The pattern of composition changes is found to follow the right eigenvector paths in composition space, and the eigenvalues provide composition-dependent retardation functions. The hydraulics is treated fairly generally and allows one to consider steady uniform or nonuniform flow fields or stochastic flow models. Both laboratory and field applications are presented. (Author's abstract)
W88-05530

**DYNAMIC MODEL OF IN-LAKE ALKALINITY GENERATION,**
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
L. A. Baker, and P. L. Brezonik.
Water Resources Research WRERAO, Vol. 24, No. 1, p 65-74, January 1988. 6 fig, 5 tab, 37 ref. EPA Cooperative Agreement CR811540-01.

Descriptors: *Alkalinity, *Path of pollutants, *Lakes, *Alkalinity generation, *Model studies, *Acid rain, Mathematical models, Mathematical equations, Ions, Differential equations, Acidification, Sulfates, Nitrates.

In-lake alkalinity generation (IAG) is important in regulation of alkalinity in lakes with long residence times, particularly seepage lakes. An IAG model based on input/output modeling concepts is presented that describes budgets for each ion involved in alkalinity regulation by a single differential equation that includes inputs, outputs, and a first-order sink term. These equations are linked to an alkalinity balance equation that includes inputs, outputs, IAG (by sulfate and nitrate reduction), and internal alkalinity consumption (by ammonium assimilation). Calibration using published lake budgets shows that rate constants are generally similar among soft water lakes (k sub SO4 approximately equal to 0.5 m/year; k sub NO3 approximately equal to 1.3/year; and k sub NH4 approximately equal to 1.5/year). Sensitivity analysis shows that predicted alkalinity is sensitive to water residence time, but less sensitive to modest changes in rate constants. The model reflects the homeostatic nature of internal alkalinity generation, in which alkalinity production increases with increasing acid input and decreases with decreasing acid inputs of HNO3 or H2SO4. (Author's abstract)
W88-05531

**MEASUREMENTS OF CESIUM AND STRONTIUM DIFFUSION IN BIOTITE GNEISS,**
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Chemical Engineering.
K. Skagius, and I. Neretnieks.
Water Resources Research WRERAO, Vol. 24, No. 1, p 75-84, January 1988. 21 fig, 1 tab, 10 ref.

Descriptors: *Underground waste disposal, *Radioactive wastes, *Path of pollutants, *Cesium, Strontium, *Diffusivity, *Groundwater movement, *Rock properties, Rocks, Radionuclides, Pores, Interstitial water, Porosity, Fate of pollutants, Sorption, Biotite gneiss, Model studies, Mathematical equations, Iodides.

A significant retardation of radionuclides transported by flowing water from an underground repository can be expected if the nuclides are able to diffuse into the water filled micropores in the rock. This diffusion into the pores will also increase surface available to interactions between the nuclides in the groundwater and the rock material, such as sorption. To calculate the retardation, it is necessary to know the sorption properties and the diffusivities of the rock matrix for radionuclides. Diffusion experiments with cesium and strontium in biotite gneiss samples were performed. Both the transport of strontium and cesium through rock samples and the concentration profiles of cesium and strontium inside rock samples were determined. The result shows that diffusion of cesium and strontium occurs in the rock material. A diffusion model was used to evaluate the diffusivity. Both pore diffusion and surface diffusion had to be included in the model to give good agreement with

the experimental data. If surface diffusion is not included in the model, the effective pore diffusivity that gives the best fit to the experimental data is higher than expected from earlier measurements of iodide diffusion in the same type of rock material. This indicates that the diffusion of cesium and strontium (sorbing components) in the rock material is caused by both pore diffusion and surface diffusion acting in parallel. (Author's abstract)
W88-05532

**COMPARATIVE METABOLISM OF NITROAROMATIC COMPOUNDS IN FRESHWATER, BRACKISH WATER AND MARINE DECAPOD CRUSTACEANS,**
California Univ., Davis. Dept. of Environmental Toxicology.
G. D. Foster, and D. G. Crosby.
Xenobiotica XENOBH, Vol. 17, No. 12, p 1393-1404, December 1987. 3 fig, 4 tab, 24 ref. National Institute of Environmental Health Sciences Fellowhsip ES07059.

Descriptors: *Toxicity, *Prawn, *Pesticides, *Water pollution, *Nitroanisole, *Nitrocresol, *Methyl parathion, *Crayfish, Crustaceans, Aromatic compounds, Organic compounds, Metabolism, Pesticides.

The metabolic pathways of p-nitroanisole, 4-nitro-m-cresol, and methyl parathion in Malaysian prawns (Macrobrachium rosenbergii), ridgeback prawns (Sicyonia ingentis) and crayfish (Procambarus clarkii) were compared. Both prawn species O-demethylated 29% and 11%, respectively, of an accumulated level of p-nitroanisole, while crayfish O-demethylated 98% of the accumulated level of nitroanisole. 4-Nitro-m-cresol oxidation was not detected in either prawn species. 5-Hydroxy-2-nitrobenzaldehyde was the major metabolite formed from nitrocresol by crayfish. Both prawn species readily dearylated methyl parathion to form p-nitrophenol and p-nitrophenyl conjugates. Crayfish displayed a similar trend in methyl parathion metabolism. Nitroreduction of 4-nitro-m-cresol was observed in ridgeback prawns, which excreted 4-nitrose-m-cresol as a minor product. Reduction products were not observed in the metabolism of any of the three species. Conjugation was the overall detoxication pathway observed in the decapods. Malaysian prawns conjugated p-nitrophenol and 4-nitro-m-cresol to form the corresponding beta-D-glucosides and sulfate monoesters. Ridgeback prawns formed beta-D-glucosides in small quanitities, preferring conjugation of p-nitrophenol and 4-nitro-m-cresol to form sulfates and unknown conjugates through a unique conjugation pathway. Crayfish conjugated the phenolic substrates to form exclusively the beta-glucosides. The unknown conjugates formed by ridgeback prawns had chromatographic properties similar to the corresponding beta-D-glucosides but were refractory to the deconjugation by alpha- or beta-glucosidase, beta-galactosidase, aryl sulfatase and beta-glucuronidase. Phenolic conjugation ability followed the order of ridgeback prawn > Malaysian prawn > crayfish. (Author's abstract)
W88-05560

**STUDIES ON SEDIMENTS OF THE RIVER LAHN: 3. TOTAL METAL UPTAKE AND BINDING CONSTANT (UNTERSUCHEN AN LAHNSEDIMENTEN 3. SATTIGUNGSKAPAZITAT UND SORPTIONSKONSTANTE),**
Marburg Univ. (Germany, F.R.). Fachbereich Chemie.
For primary bibliographic entry see Field 2K.
W88-05561

**TRANSATLANTIC TRANSPORT OF SULFUR,**
Atmospheric Environment Service, Downsview (Ontario).
D. M. Whelpdale, A. Eliassen, J. N. Galloway, H. Dovland, and J. M. Miller.
Tellus TELLAL, Vol. 40B, No. 1, p 1-15, February 1988. 3 fig., 1 tab, 38 ref.

Descriptors: *Water pollution sources, *Sulfur, *North America, *Europe, *Air pollution, *Acid rain, *Path of pollutants, *North Alantic Ocean, *Precipitation, *Transatlantic transport, Sulfates, Mathematical models.

This paper examines the transport of North American sulfur emissions across the North Atlantic Ocean to Europe. A review of available precipitation sulfate data from the North Atlantic and adjacent coastal regions yields a concentration field which is consistent with known source distributions and meteorological factors. The marine background precipitation excess sulfate concentration is found to be 6-8 microequivalents per liter and the concentration of SO4(--) to decrease from >50 microequivalents per liter with offshore flows at the North American east coast to 8-15 microequivalents per liter with onshore flows at the European west coast. The decay is consistent with a distance constant of 2400 km and a residence time of approximately 80 hours, and in turn, corresponds to a transatalantic flux of anthropogenic sulfur of 0.3-0.4 Tg per a. A second independent estimate, based on the application of a climatological dispersion model, which accounts for long-term average diffusion, wet and dry deposition, and SO2 to SO4(-) transformation yields a flux of North American anthropogenic sulfur at the European west coast of 0.2 Tg per a, in agreement with the first estimate. At the distance of the European west coast, the North American anthropogenic emissions account for ca. 4 microequivalents S per liter in precipitation-less than the marine background of 6-8 microequivalents per liter, and much less than the annual average SO4(--) concentration value of ca. 30 microequivalents per liter appropriate for much of the coastal region. It is concluded that, on average, the amount of North American anthropogenic sulfur reaching Europe is small compared to that from other sources. (Author's abstract)
W88-05573

**ESTIMATE OF THE IMPORTANCE OF DRY DEPOSITION AS A PATHWAY OF ACIDIC SUBSTANCES FROM THE ATMOSPHERE TO THE BIOSPHERE IN EASTERN CANADA,**
Atmospheric Environment Service, Downsview (Ontario).
A. Sirois, and L. A. Barrie.
Tellus TELLAL, Vol. 40B, No. 1, p 59-80, February 1988. 10 fig, 10 tab, 31 ref.

Descriptors: *Sulfate, *Nitrate, *Canada, *Pollution sources, *Dry deposition, *Acid rain, *Acid deposition, *Path of pollutants, *Chemistry of precipitation, Ecosystems, Peroxyacetyl nitrate, Land-use types, Wind.

The relative importance of dry and wet deposition of sulfate and nitrate over southeastern Canada was examined using daily air and precipitation chemistry observations made at six rural stations of the Air and Precipitation Monitoring Network during the period 1979-1982. Dry deposition was calculated from these air concentrations using deposition velocity information on land-use types, on atmospheric wind speed and stability and on dry deposition rates from over 80 published studies. Despite the large uncertainty in dry deposition estimates which is associated with the complexity of the process, valuable conclusions emerge. It is estimated that total annual deposition varies between 10 to 86 mmole per sq m and 13 to 62 mmole per sq m for SO4(--) and NO3(-), respectively. To eastern Canada 22% and 30% of the total SO4(--) and NO3(-) is dry deposited, respectively. Depending on location, the contribution of SO2 to the dry deposition of sulfur ranges from 37% to 78%. It tends to decrease with increasing distance from major sources. In eastern Canada, the best estimate of the fraction of the total dry deposition of nitrogen contributed by NO2 and HNO3 is in the range 50% to 60% and 31% to 45%, respectively, depending on location. The uncertainty in the NO2 estimate is large, approaching a factor of 3.5. Even if peroxyacetyl nitrate dry deposition velocities are equal to that of NO2 (they are expected to be lower), the contribution of peroxyacetyl nitrate to total nitrate deposition is negligibly small. Both dry and wet deposition are episodic in nature. It is estimated that the top-20% deposition events yield 47% to 70% of the total deposition. (Author's abstract)
W88-05574

**HEPATITIS A VIRUS AND POLIOVIRUS 1 INACTIVATION IN ESTUARINE WATER,**
A. M. Patti, A. L. Santi, R. Gabrieli, S. Fiamma, and M. Cauletti.
Water Research WATRAG, Vol. 21, No. 11, p 1335-1338, November 1987. 6 fig, 15 ref.

Descriptors: *Viruses, *Wastewater disposal, *Estuaries, *Estuarine environment, *Virus inactivation, Biological properties, Water properties, Human diseases, Wastewater, Municipal wastewater, Rio Martino.

The hepatitis A virus (HAV) and poliovirus 1 were added to estuarine water samples from Rio Martino, a canal receiving industrial and municipal waste, and their stability in maintenance medium was compared to that in untreated water samples and in samples treated by heat and filtration. The inactivation curves show that the inactivating factor is biological in nature. It is possible that this biological factor (s), which had previously only been described in marine water, reaches the sea from canals receiving municipal wastes. (Author's abstract)
W88-05589

**INCIDENCE OF YEASTS IN COASTAL SEA WATER OF THE ATTICA PENINSULA, GREECE,**
Athens School of Hygiene (Greece).
For primary bibliographic entry see Field 2L.
W88-05593

**NITROGEN GAS SUPERSATURATION IN THE RECENT SEDIMENTS OF LAKE ERIE AND TWO POLLUTED HARBORS,**
Wright State Univ., Dayton, OH. Dept. of Chemistry.
N. J. Fendinger, and D. D. Adams.
Water Research WATRAG, Vol. 21, No. 11, p 1371-1374, November 1987. 3 fig, 25 ref. OWRT A-059-OHIO Funding, EPA Contract R806757-01-1.

Descriptors: *Nitrogen, *Denitrification, *Lake sediments, *Interstitial water, *Lakes, *Harbors, *Path of pollutants, *Lake Erie, Sediments, Fate of pollutants, Pollutants, Cores, Saturation, Diffusion, Denitrification, Nitrogen removal.

Nitrogen gas distributions in sediment pore water were determined for cores collected in Lake Erie and two nearby harbors. Concentrations of N2 gas ranged from 11.9 to 37.0 ml/l and from 8.9 to 58.3 ml/l for open lake and polluted harbor sediments, respectively. Maximum concentrations in the harbor sediments were as high as 3.5 times N2 saturation calculated for the overlying water. Indirect diffusive flux estimates for nitrogen gas ranged from 20 to 32% of the particulate nitrogen sedimentation rate in Lake Erie. At one location, the amount of nitrogen gas lost by diffusion was calculated to be greater than the nitrogen deposited to the sediments. Nitrogen gas production and diffusive loss from surficial sediments probably represents a major pathway for nitrogen removal from Lake Erie. (Author's abstract)
W88-05594

**OCCURRENCE OF ROTAVIRUSES AND ENTEROVIRUSES IN RECREATIONAL WATERS OF OAK CREEK, ARIZONA,**
Arizona Univ., Tucson. Dept. of Microbiology and Immunology.
J. B. Rose, R. L. Mullinax, S. N. Singh, M. V. Yates, and C. P. Gerba.
Water Research WATRAG, Vol. 21, No. 11, p 1375-1381, November 1987. 1 fig, 4 tab, 32 ref.

Descriptors: *Viruses, *Recreation facilities, *Epidemiology, *Pollutant identification, *Rotaviruses, *Pathogens, *Enteroviruses, Freshwater recreation, Recreational waters, Coxsackie virus, Arizona, Bacteria, Swimming, Recreation, Oak Creek, Water quality standards, Human diseases.

Recent epidemiological studies have shown a relationship between swimming in recreational waters meeting bacteriological standards and gastroenteritis with a suggested viral etiology. No previous studies have been conducted in the United States on the occurrence of human pathogenic enteric viruses in freshwater recreational areas. The presence of enteroviruses and rotaviruses was investigated in Oak Creek, Arizona, a heavily used recreational area. Water samples were filtered through positively charged filters (168-1555 l.), eluted with beef extract, and assayed for human enteroviruses or rotavirus. Of these, nine samples exceeded the Arizona State recommended limit of 1 PFU /40 liters for full body contact in effluent dominated recreational waters. Several virus positive samples met the recommended fecal coliform standards (200 CFU/100 ml) for recreational waters indicating the inadequacy of bacterial standards for monitoring viral water quality. The isolation of the pathogenic enteric viruses (i.e., poliovirus 1, echovirus 1, coxsackievirus B1 and B6 and rotavirus) from this popular recreational water demonstrates the potential for transmission of viral disease. (Author's abstract)
W88-05595

**EQUILIBRIUM APPROACHES TO NATURAL WATER SYSTEMS-6. ACID-BASE PROPERTIES OF A CONCENTRATED BOG-WATER AND ITS COMPLEXATION REACTIONS WITH ALUMINIUM(III),**
Umea Univ. (Sweden). Dept. of Inorganic Chemistry.
For primary bibliographic entry see Field 2K.
W88-05599

**ORGANOCHLORINE RESIDUES IN NORTHEASTERN ALBERTA OTTERS,**
Alberta Environmental Centre, Vegreville.
J. D. Somers, B. C. Goski, and M. W. Barrett.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 5, p 783-790, November, 1987. 1 fig, 3 tab, 15 ref.

Descriptors: *Path of pollutants, *Chlorinated hydrocarbons, *Alberta, *Otters, *Organic pesticides, *Bioindicators, *Polychlorinated biphenyls, *Pesticide residues, Pesticides, Tissue analysis, Indicators, Liver, Heptachlor, DDT, Aldrin, Dieldrin, Endrin, Methoxychlor, Lipids, Monitoring.

Organochlorine residue data were collected in otters from aquatic areas in remote, forested stream and lake habitats in northeastern Alberta. Lipid and liver samples were analyzed for various pesticides and Aroclors and for polybrominated biphenyls, using procedures previously described. Overall, residue levels were found to be low and probably biologically insignificant, with all compounds ranging from nondetectable (ND) to 0.1 microgram/g in lipid, and from ND to 0.01 microgram/g in liver, although PCB residues ranging from ND to 2.34 micrograms/g in lipid and from ND to about 0.1 microgram/l in liver were found. No difference in residues was evident between the age or sex-class of otters. The presence of low concentrations of DDD, the chlordanes, heptachlor epoxide, and dieldrin reflect the catabolic function of the liver enzyme systems compared to the storage function of lipids. It is suggested that the identification of PCB isomers should be emphasized in future monitoring of carnivores (if total PCB residues are high), and that monitoring in Alberta should probably be limited to areas of intensive agricultural production. (Doria-PTT)
W88-05617

**DISPOSITION OF TOXIC PCB CONGENERS IN SNAPPING TURTLE EGGS: EXPRESSED AS TOXIC EQUIVALENTS OF TCDD,**
State Univ. of New York at Albany. Dept. of Chemistry.
A. M. Bryan, W. B. Stone, and P. G. Olafsson.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 5, p 791-796, November, 1987. 1 fig, 3 tab, 13 ref.

Descriptors: *Path of pollutants, *Polychlorinated biphenyls, *Dioxin, *Turtles, *Eggs, *Lipids, *Tissue analysis, Aquatic animals, Toxicity, Toxins, Chromatography, Gas chromatography, Metabolism.

A study was undertaken to determine if the heavy fat bodies of the female snapping turtle provide a sufficiently large sink to retain toxic PCB congeners and prevent their incorporation into the eggs. PCB mixtures were analyzed by high-resolution capillary gas chromatography. Differences in partitioning of the total toxic equivalents of TCDD were found between the yolk versus the white and shell of the eggs, with a strong preference for disposition in the yolk. Data indicated that the fat deposits of the female turtle did not prevent toxic congeners from being disposed in the egg. Of the five toxic congeners present in the yolk as well as in the white and shell, two made up more than 99% of the total toxicity, and more than 95% of the total toxicity resided in the yolk. (Doria-PTT)
W88-05618

**GROUNDWATER TRANSPORT OF THE HERBICIDE, ATRAZINE, WELD COUNTY, COLORADO,**
Colorado State Univ., Fort Collins. Inst. of Rural Environmental Health.
M. P. Wilson, E. P. Savage, D. D. Adrian, M. J. Aaronson, and T. J. Keefe.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 5, p 807-814, November, 1987. 3 fig, 1 tab, 18 ref.

Descriptors: *Path of pollutants, *Atrazine, *Herbicides, *Colorado, *Groundwater pollution, Pesticides, Water pollution, Chromatography, Gas chromatography, Irrigation water, Public health, Groundwater movement, Plumes.

The groundwater transport of atrazine, the most commonly used herbicide in the region, was studied in the South Platte River Valley of Weld County, Colorado. Samples were withdrawn from four water wells located at gradient points above, beneath, and below irrigated, atrazine-treated fields. Analyses were performed by a gas chromatograph equipped with a nitrogen-phosphorus detector. Atrazine concentrations in groundwater samples collected from Wells 1 and 3 were below detection. Both Well 2 and Well 4 yielded groundwater samples with atrazine concentrations ranging between 1.1 and 2.3 ppb. Atrazine levels in Well 4 samples are considered to represent points along the concentration of a contaminant plume moving past the well, the result of atrazine transport processes. The regression of Well 4 data suggests that the samples were collected from the tail of the contaminant plume and that higher concentrations may have occurred previous to the first sampling date. (Doria-PTT)
W88-05619

**POLYCHLORINATED BIPHENYLS IN BLUE CRABS FROM SOUTH CAROLINA,**
South Carolina State Dept. of Health and Environmental Control, Columbia.
J. M. Marcus, and T. D. Mathews.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 5, p 857-862, November, 1987. 1 fig, 3 tab, 10 ref.

Descriptors: *Polychlorinated biphenyls, *Path of pollutants, *Crabs, *South Carolina, *Tissue analysis, Crustaceans, Chromatography, Electron capture gas chromatography, Environment, Estuarine environment, Shellfish.

Polychlorinated biphenyl residues were studied in blue crabs trapped in Beaufort County, SC between June and October, 1985; the study was undertaken because of reported declining commercial crab catch rates. Samples were analyzed by electron capture gas chromatography. Preliminary screening revealed a gradient pattern of PCBs in backfin tissue, with higher levels observed nearer a wastewater treatment facility outfall. Sediment PCB concentrations ranged from 24.2 mg/kg dry weight at the outfall to 0.010 mg/kg at the mouth of Campbell Creek. The highest mean total concentration in crabs was 0.861 mg/kg immediately at the outfall, with concentrations of 0.227 mg/kg and 0.158 mg/kg measured 100 m north and 300 m south of the outfall, respectively. The portion of Campbell Creek with the highest mean tissue concentration was also the area of highest sediment levels. Overall, PCB levels in blue crabs in this study fell within the ranges observed in South Carolina and elsewhere. (Doria-PTT)
W88-05620

**PCB CONCENTRATIONS IN WINTER FLOUNDER FROM LONG ISLAND SOUND, 1984-1986,**
National Marine Fisheries Service, Milford, CT. Milford Lab.
R. A. Greig, and G. Sennefelder.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 5, p 863-868, November, 1987. 4 tab, 8 ref.

Descriptors: *Path of pollutants, *Polychlorinated biphenyls, *Long Island Sound, *Flounders, *Tissue analysis, Fish, Liver, Chromatography, Gas liquid chromatography, Environment, Estuarine environment, Gonads.

Winter flounder were collected from several stations in Long Island Sound and their gonads and liver analyzed for PCBs. Analyses were conducted by gas liquid chromatography. Data collected in 1985-86 followed the same pattern observed in 1984-85 samples. Ovaries contained a mean value of 0.16 ppm in 1984 and 0.26 ppm in 1985, while livers contained 0.42 ppm in 1984 and 0.30 ppm in 1986. These data are compared to results of published studies on fish obtained from along the Atlantic Coast. (Doria-PTT)
W88-05621

**POLYCHLORINATED DIBENZO-P-DIOXINS IN BLUE MUSSEL FROM MARINE COASTAL WATER IN JAPAN,**
Setsunan Univ., Neyagawa (Japan).
H. Miyata, K. Takayama, J. Ogaki, T. Kashimoto, and S. Fukushima.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 5, p 877-883, November, 1987. 3 fig, 4 tab, 14 ref.

Descriptors: *Dioxins, *Path of pollutants, *Chlorinated hydrocarbons, *Mussels, *Japan, *Marine environment, *Coastal waters, Mollusks, Environment, Chromatography, Gas chromatography, Tissue analysis, Sample preparation, Polychlorinated biphenyls, Bioindicators.

The extent of pollution of PCDDs in Japanese marine coastal waters was examined using blue mussel as a biological indicator. PCDDs were detected in all samples of blue mussel from Osaka and Hokkaido. Average concentrations were 250 ppt in Hokko (Osaka), 190 ppt in Misaki-cho (Osaka), 30 ppt in Funka Bay (Hokkaido), and 7.6 ppt in Rishiri Island (Hokkaido). The degree of pollution was roughly proportional to that of PCBs. Shellfish from Hokko were polluted six times more heavily with PCBs than shellfish from Misaki-cho, whereas PCB pollution was only 1.3 times as heavy in the former as in the latter. Variations of pollutant levels over time are discussed. It is suggested that the source of PCBs may be different from the source of PCDDs. (Doria-PTT)
W88-05623

**ACUTE TOXICITY OF CADMIUM TO EIGHT SPECIES OF MARINE AMPHIPOD AND ISOPOD CRUSTACEANS FROM SOUTHERN CALIFORNIA,**
Korea Ocean Research and Development Inst., Seoul (Republic of Korea).
J.-S. Hong, and D. J. Reish.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 5, p 884-888, November, 1987. 1 tab, 14 ref.

Descriptors: *Toxicity, *Cadmium, *Marine animals, *Isopods, *Amphipods, *California, Heavy metals, Aquatic animals, Crustaceans, Lethal limit, Bioassay, Assay.

The effects of CdCl2 were investigated on six species of amphipods and two species of isopods under similar experimental conditions. Cadmium was selected for the study because it is an important constituent of municipal wastes discharged into southern California marine waters. Static acute bioassays were carried out using four test concentrations plus a control series. Mean LC50 values in the different species ranged from 0.24 mg/l to 7.12 mg/l (96 h) and from 0.2 mg/l to 2.14 mg/l (7 d). Statistical analysis indicated four significantly separated groups according to survivability to cadmium. The most sensitive group included Rhepoxynius and Jaeropsis; next were Elasmopus and Chelura, followed by Grandidirella and Coropohium. Limnoria was most tolerant. It is concluded that amphipods and isopods are useful in toxicity testing because of their small size and abundance in the field. (Doria-PTT)
W88-05624

**ACUTE TOXICITY OF ZINC TO JUVENILE AND SUBADULT RAINBOW TROUT, SALMO GAIRDNERI,**
Scarborough Coll., Westhill (Ontario). Life Sciences Div.
J. D. Meisner, and W. Quan Hum.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 5, p 898-902, November, 1987. 2 tab, 12 ref.

Descriptors: *Toxicity, *Zinc, *Trout, *Juvenile growth stage, *Immature growth stage, Heavy metals, Fish, Growth stages, Bioassays, Median tolerance limit.

Bioassays using flow-through conditions were conducted to investigate the toxicity of zinc to juvenile and subadult rainbow trout obtained from Mt. Albert, Ontario. The 96-h median lethal concentrations of zinc to juveniles and subadults were 26.0 and 24.0 mg/l. The slopes of the dose effect curves and the potency of zinc in both bioassays did not differ significantly. LC50s suggest that juvenile and subadult rainbow trout are equally tolerant of zinc. It is possible that the influence of body weight on zinc tolerance in rainbow trout decreases after the mid-juvenile or adult stage is reached. This would disqualify the body weight-zinc tolerance relationship derived for the younger stages as a tool for the prediction of acute toxicity to adults. It is concluded that further study of the acute toxicity of zinc to the older stages of salmonids is required. (Doria-PTT)
W88-05626

**IMPORTANCE OF LIQUID WATER CONCENTRATION IN THE ATMOSPHERIC OXIDATION OF SO2,**
Nevada Univ., Reno. Desert Research Inst.
D. Lamb, D. F. Miller, N. F. Robinson, and A. W. Gertler.
Atmospheric Environment ATENBP, Vol. 21, No. 11, p 2333-2344, November, 1987. 9 fig, 1 tab, 26 ref. EPRI Contract No. RP 1434-3.

Descriptors: *Acid rain, *Air pollution, *Oxidation, *Atmospheric water, *Chemical reactions, *Sulfates, *Sulfur dioxide, Condensates, Clouds, Chemistry, Hazes, Aerosols, Model studies, Humidity, Acidity.

The concentration of condensed water available for aqueous chemical reactions is viewed as a fundamental parameter of the heterogeneous conversion of gaseous SO2 to particulate sulfate. Results are presented from a series of dispersed-phase experiments in a cloud chamber, in which the magnitude of this parameter was allowed to vary widely, demonstrating that the heterogeneous SO2 conversion rate in hazes is generally limited by the small concentration of condensed water. This limitation precludes the heterogeneous oxidation pathway from being important in the atmosphere during haze episodes except under extreme conditions of high humidities and aerosol loadings. In clouds, on the other hand, the liquid water concentrations are relatively large, permitting chemically related factors, such as pH-dependent equilibria and oxidant abundances, to limit the SO2 conversion rate. (Author's abstract)
W88-05628

**CUMULUS CLOUD TRANSPORT, SCAVENGING AND CHEMISTRY: OBSERVATIONS AND SIMULATIONS,**
Atmospheric Environment Service, Downsview (Ontario). Cloud Physics Research Div.
For primary bibliographic entry see Field 2K.
W88-05629

**CASE STUDIES ON THE CHEMICAL COMPOSITION OF FOGWATER: THE INFLUENCE OF LOCAL GASEOUS EMISSIONS,**
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
C. A. Johnson, L. Sigg, and J. Zobrist.
Atmospheric Environment ATENBP, Vol. 21, No. 11, p 2365-2374, November, 1987. 4 fig, 5 tab, 31 ref. Schweizerischer Nationalfond No. NFP 14.

Descriptors: *Acid rain, *Fog, *Chemical composition, *Chemical reactions, *Air pollution, *Hydrochloric acid, Case studies, Acidity, Hydrogen ion concentration, Sulfuric acid, Sulfates, Nitrates, Ammonium compounds, Aerosols, Sulfur, Fate of pollutants, Incineration.

Sequential samples were taken during two fog events over several hours and analyzed chemically. Preliminary measurements of gases (HCl, HNO3, NH3) and aerosols (H2SO4, NH4NO3, NH4Cl, and ammonium sulfates) were also made. The uptake of gaseous HCl in the fog droplets was a major source of acidity: in extreme cases, pH values of 2.08 and 1.94 and Cl(-) concentrations up to 0.01 M were observed. HCl originated from a local source, most probably a refuse incinerator from which plumes of the stack gas reached the sampling site. The NH4(+), NO3(-), and SO4(--) concentrations (in the range of 0.1-2 mmol/l) were regulated by the inputs of aerosols and the liquid water content of the fog. The contribution of dissolved S(IV) (0.06-0.27 mmol/l) to the total aqueous sulfur varied with time, according to the pH-dependent solubility of SO2 and to oxidation reactions. (Author's abstract)
W88-05630

**CHEMICAL COMPOSITION OF ATMOSPHERIC PRECIPITATION IN CZECHOSLOVAKIA, 1976-1984: I. MONTHLY SAMPLES,**
Ustredni Ustav Geologicky, Prague (Czechoslovakia).
B. Moldan, M. Vesely, and A. Bartonova.
Atmospheric Environment ATENBP, Vol. 21, No. 11, p 2383-2395, November, 1987. 5 fig, 8 tab, 12 ref.

Descriptors: *Water pollution sources, *Path of pollutants, *Acid rain, *Chemistry of precipitation, *Atmospheric water, *Czechoslovakia, *Water sampling, Monthly distribution, Chemical composition, Distribution, Seasonal distribution, Sampling, Chemical analysis, Water analysis, Statistical analysis, Acidity, Mineralization, Seawater, Sulfur, Coal, Sulfates, Air pollution effects, Fate of pollutants.

The results of chemical analyses of monthly atmospheric precipitation samples from 12 stations in Czechoslovakia are presented. The sampling at the station with the longest record (Hradek u Pacova, 80 km SE from Prague) covers nine years. There is no clear regional pattern within the sampled territory, but a spring maximum was observed for most components. For SO4(--) and acidity, a downward trend was indicated. Statistical analyses show that the important sources of mineralization of precipitation water are (in order of importance): coal combustion; sea spray; terrigenous dust; car exhaust; cement production; and 'European background' sulfur. (Author's abstract)
W88-05632

**BACTERIAL UTILIZATION OF FORMIC AND ACETIC ACID IN RAINWATER,**
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2K.
W88-05633

**CONCENTRATIONS, SPECIATION AND DECOMPOSITION OF ORGANOLEAD COMPOUNDS IN RAINWATER,**
Essex Univ., Colchester (England). Dept. of Chemistry.
For primary bibliographic entry see Field 2K.
W88-05634

**CLASSIFICATION OF SUSPENDED PARTICLES IN DEPOSITION SAMPLES AND RUN-OFF WATER SAMPLES FROM A LIMESTONE CATHEDRAL,**
Antwerp Univ., Wilrijk (Belgium). Dept. of Chemistry.
L. A. Leysen, E. J. Roekens, H. Storms, and R. E. Van Grieken.
Atmospheric Environment ATENBP, Vol. 21, No. 11, p 2425-2433, November, 1987. 1 fig, 6 tab, 14 ref.

Descriptors: *Acid rain, *Suspended solids, *Deterioration, *Limestone, *Weathering, *Buildings, Belgium, Particulate matter, Runoff, Air pollution effects, Radiation, X-rays, Automation, Multivariate analysis, Chemical composition, Calcium carbonate, Sulfates, Nitrates, Chromatography.

In a study on the mechanism of the air-pollution induced deterioration of the limestone St. Rombouts cathedral in Mechelen, Belgium, automated electron-probe X-ray micro-analysis combined with multivariate analysis was used to characterize the suspension particles in runoff water and in local wet and dry deposition samples. Altogether, about 10,000 individual particles were sized, analyzed, and classified according to their chemical composition. It was found that the runoff water samples were highly enriched in CaCO3 particles, resulting from the stone-erosion by overflowing rainwater, while the Si-rich group was the most abundant one in the deposition samples. Several other particle types were found. Ion chromatography analysis of the runoff water showed 200-1700 mg/l of sulfate and 20-110 mg/l of nitrate. (Author's abstract)
W88-05635

**ANALYSIS OF STATISTICAL MONITORING NETWORK DESIGN,**
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W88-05636

**CONTROLLING CROSS-MEDIA POLLUTANTS.**
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 5G.
W88-05692

**TECHNICAL SUPPLEMENT TO DREDGED MATERIAL DISPOSAL STUDY, US NAVY HOME PORT, EVERETT, WASHINGTON,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
S. A. Adamec, B. H. Johnson, A. M. Teeter, and M. J. Trawle.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report HL-87-12, September 1987. Final Report. 53 p, 6 fig, 3 tab, 9 ref, 21 plates.

Descriptors: *Fate of pollutants, *Waste disposal, *Model studies, *Dredging, *Ocean dumping, *Pipes, Bottom disposal, Capping, Water currents, Path of pollutants, Mathematical models, Washington.

A series of numerical model runs predicting the short-term fate of contaminated and uncontaminated dredged materials disposed in open water was performed. The conditions tested were intended to represent typical conditions for the disposal of material at the proposed US Navy Home Port site at Everett, Washington. Two types of disposal

methods were tested: a bottom disposal of contaminated material and a capping operation with uncontaminated material using hydraulic dredging and pipe discharge. Long-term predictions of disposal mound configuration and capping thicknesses based on hand calculations were also made. Three current conditions and four dredged material clumping percentages were simulated for the bottom disposal of the contaminated material. Three discharge pipe configurations and four pipe discharges with varying density were simulated for the capping operation with uncontaminated material. General conclusions from the modeling are: (1) For a single 4,000 cu yd barge disposal of material, more than 98% of the disposed contaminated material will deposit within 1 hr for all tests at 265 ft of water depth. The disposed contaminated material will deposit within an area of 800 by 1,000 ft with a maximum thickness of approximately 0.60 ft; (2) More than 90% (at a discharge rate of 30 cu yd of solids/min for 47 min) of the disposed uncontaminated capping material from each sweep of the confined surface discharge will deposit within an hour. The swath of deposition will be less than 300 ft wide with a maximum thickness of approximately 0.09 ft. Bottom impact velocities will be < 0.5 fps; (3) More than 95% (at a discharge rate of 30 cu yd of solids/min for 47 min) of the disposed capping material from the 50- and 150-ft stationary downpipe capping operations will deposit within an hour. The area of deposition will have a radius of < 100 ft with a maximum thickness of approximately 2.0 ft. Bottom impact velocities will be < 1.1 fps. (Lantz-PTT)
W88-05706

**WASTEWATER CHARACTERIZATION AND HAZARDOUS WASTE SURVEY, HICKAM AFB, HI,**
Air Force Occupational and Environmental Health Lab., Brooks AFB, TX.
R. D. Binovi, R. A. Tetla, and F. E. Slavich.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A181 345. Price codes: A04 in paper copy, A01 in microfiche. USAFOEHL Report No. 87-064EQ0688EEF, May 1987. Final Report. 87 p, 13 fig, 7 tab, 13 ref, 10 append.

Descriptors: *Wastewater composition, *Hazardous wastes, *Water pollution sources, *Hickam Air Force Base, *Hawaii, Lift stations, Oil-water separation, Chemical oxygen demand, Chlorides, Oil wastes, Industrial wastewater, Saline water intrusion, Phenols, Sulfides, Silver, Chromium, Water quality control, Sea water.

The US Air Force Occupational and Environmental Health Laboratory characterized the industrial wastewater in the Hickam AFB sewers and conducted a hazardous waste survey. The scope of the survey included characterizing the major industrial wastewater discharges from the base and determining if applicable discharge standards were being violated. A total of 23 sampling sites were evaluated including 10 lift stations and 10 oil/water separators. The hazardous waste survey included visiting 44 shops to determine chemical usage and hazardous materials management practices including collection, storage, disposal practices and accumulation points. Seawater infiltration of the sewer was found to cause chloride concentration limitations to be exceeded at four locations. Seawater was also a contributor to high chemical oxygen demand (COD) concentrations. The COD limitation was exceeded at 11 locations. The photographic wastewater from building 2045 exceeded the limits for chlorides, sulfides, phenols, silver, and chromium. Recommendations from the study include: (1) Determine where the seawater is infiltrating the sewers and take action to reduce the chloride level to below the limit; (2) Install a pretreatment plant for the 548 RTG photographic wastewater; (3) Develop a comprehensive waste analysis plan; (4) Increase hazardous waste monitoring; and (5) Service the silver recovery cartridge at 548 RTG. (Author's abstract)
W88-05714

**NORTH ALABAMA WATER QUALITY ASSESSMENT. VOLUME VII: CONTAMINANTS IN BIOTA,**
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
D. L. Dycus.
Available from the National Technical Information Service, Springfield, VA 22161, as DE87-900603. Price codes: A04 in paper copy, A01 in microfiche. Tennesee Valley Authority Report No. TVA/ONRED/AWR--86/33, April 1986. 94 p, 1 fig, 18 tab, 40 ref, 3 append.

Descriptors: *Path of pollutants, *Bioaccumulation, *Alabama, *Wilson Reservoir, *Pickwick Reservoir, Fate of pollutants, Polychlorinated biphenyls, Turtles, Clams, Bass, Crappie, Tissue analysis, Chemical analysis, Cadmium, Catfish, Biomonitoring, Priority pollutants, Public health.

Results and recommendations from a two-part study conducted in fall 1984 to determine concentrations of various contaminants in biota from Wilson and upper Pickwick Reservoirs in north Alabama, are presented. One part of this study was a 'screening' effort where fish, clams, and turtles were analyzed as composites for contaminants on the EPA's list of priority pollutants. The other part was specific to polychlorinated biphenyls (PCBs) because there was a known source of PCBs. Fish fillets were analyzed individually for this part of the study. Analysis of biological samples for priority pollutants identified few contaminants present in detectable quantities. Of those detected, some were sufficiently low to be of no concern. The presence of cadmium in turtle livers and clam flesh indicated a need for further evaluation because this metal is highly toxic to aquatic life. Results of PCB analyses indicated largemouth bass and crappie contamination levels were well below the FDA limit of 2.0 micrograms/gm. Highest PCB concentrations occurred in catfish from Wilson Reservoir. Twenty-two of 45 individuals from Wilson Reservoir exceeded the FDA limit and the overall average was 2.6 micrograms/gm. As a result of these data Alabama public health officials prohibited the sale of catfish from Wilson Reservoir beginning in June 1985. Efforts to collect catfish from Wheeler Reservoir (upstream of Wilson) and Pickwick Reservoir (downstream of Wilson) to determine PCB concentrations were initiated in August 1985. Other recommendations include identification of PCB sources around Wilson Reservoir and an annual collection of catfish to determine when Wilson Reservoir can be reopened to commercial sale of catfish. (Lantz-PTT)
W88-05716

**ECOLOGICAL RECOVERY AFTER RECLAMATION OF TOXIC SPOILS LEFT BY COAL SURFACE MINING. PHASE II: AN ASSESSMENT OF ENVIRONMENTAL CHANGES FOLLOWING INTENSIVE REMEDIAL TREATMENTS,**
Tennessee Valley Authority, Norris. Div. of Land and Economic Resources.
For primary bibliographic entry see Field 4C.
W88-05718

**WES-TNO CONTAMINANT MOBILITY RESEARCH,**
Army Engineer Waterways Experiment Station, Vicksburg, MS.
J. M. Marquenie.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A181 625. Price codes: A02 in paper copy, A01 in microfiche. Report No. R 87/15, January 26, 1987. Final Technical Report. 9 p. Contract No. DAJA45-85-C-0027.

Descriptors: *Path of pollutants, *Dredging, *Times Beach, *New York, *Water pollution effects, Soil contamination, Sediment contamination, Earthworms, Mussels, Biomonitoring, Waterfowl, Tissue analysis, histopathology, Surveys.

Ten European scientists evaluated research programs in relation to contaminant mobility from dredged materials in ecosystems. Intensive investigations and inventories were conducted at the Times Beach (New York) confined disposal site, which aided in the development of research objectives and future management concerns. Three Benton Harbor (ID) field sites were inspected, transects were lined out, and sampling stations were selected. From each sampling station replicate soil or sediment samples were collected. Soil and sediment samples for an earthworm bioassay were collected from different depths representing the significant horizons that had been developed over time. A sampling station to collect background mussels for mussel watching at Times Beach was identified. Mussels were collected and exposed in Times Beach and Lake Erie. Mussels were also exposed at key locations in the Buffalo River in order to given an early warning of future contaminant related dredging problems in the Buffalo River. High numbers of several waterfowl species have been found breeding in the Times Beach wetland. In order to assess uptake of contaminants that in the disposal site are present in the waterfowl, young ducks were shot prior to fledging. The bodies were subjected to a full histopathological inspection, including light-microscopic examination of the tissues. Aquatic and benthic inventories were conducted. (Lantz-PTT)
W88-05721

**ROLE OF BACTERIAL POLYMERS IN METAL RELEASE INTO WATER,**
Harvard Univ., Cambridge, MA. Lab. of Microbial Ecology.
For primary bibliographic entry see Field 2F.
W88-05729

**SURVIVAL AND VIRULENCE OF WATER-BORNE PATHOGENIC BACTERIA IN POTABLE WATERS,**
Montana State Univ., Bozeman. Dept. of Microbiology.
G. A. McFeters.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 79-85, 22 ref. EPA Grant Nos. R807092, R805230, and CR810015.

Descriptors: *Aquatic bacteria, *Groundwater pollution, *Fate of pollutants, *Pathogenic bacteria, *Potable water, *Water quality control, Microbiological studies, Bioindicators, Coliforms, Bacteria, Drinking water, Activated carbon, Public health, Injured bacteria.

The comparative survival of various indicator and enteric pathogenic bacteria in groundwater was studied using membrane diffusion chambers. Although there was some variation among the 29 coliforms and 20 enterococcus cultures examined, the survival in each group was relatively constant. A number of media and methods have been developed that effectively cultivate stressed indicator bacteria. m-T7 medium was developed specifically for the recovery of injured total and fecal coliforms in drinking water. The m-T7 method was used to survey operating drinking water treatment and distribution systems for the presence of injured coliforms that were undetected with currently accepted media. Over 100 samples of drinking water obtained at various points within the treatment plant and the distribution network of several systems were analyzed for coliform bacteria using m-Endo and m-T7 media. The mean recovery with m-Endo medium was less than 1/100 ml, while it ranged between 5 and 67/100 ml with m-T7 agar. In addition, the majority of the samples giving positive results with m-T7 medium yielded no detectable coliforms with m-Endo agar. Comparison of colony counts on the two media showed that over 95% of the coliform bacteria in these samples were injured. Indicator and enteropathogenic bacteria also colonize granular activated carbon (GAC) used to treat drinking water. This colonization was dependent upon the microbial community on the GAC surface. The findings of these studies indicate that: (1) the survival in water of coliforms and enteropathogenic bacteria correlates in some cases; (2) injury of indicator and pathogenic bacteria can occur within drinking water systems; (3) methods are available that effectively detect injured coliforms; (4) the vast majority of coliforms within these systems may be undetected because sublethal stress that leads to decreased detection on conventional media; (5) pathogenic bacteria,

except enteropathogenic E. coli (ETEC), also become injured but at higher levels of stressing agents; (6) injured pathogens express virulence determinants following recovery; and (7) surface-associated bacteria can present a health threat in water. As a result, injured and GAC-associated coliforms are of public health significance, and their detection affords an added measure of sensitivity to assist in the early detection of treatment deficiencies or contamination within aquatic systems. (Lantz-PTT)
W88-05732

**BIOLOGY OF GALLIONELLA,**
Goeteborg Univ. (Sweden). Dept. of Marine Microbiology.
E. L. Hallbeck, and K. Pedersen.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 87-95, 6 fig, 2 tab, 15 ref.

Descriptors: *Iron bacteria, *Aquifer characteristics, *Well water, *Biofilms, *Clogging, *Biological studies, *Gallionella, *Microbiological studies, *Groundwater quality, Water temperature, Iron, Bacterial growth, Aquifers, Dissolved oxygen, Habitats, Oxygen.

The occurrence of Gallionella ferruginea has been known since 1836. The bacterium is characterized by a beanshaped cell that produces a twisted stalk composed of up to 80 definite, linear, nonliving strands. It is common in iron-bearing waters and many groundwater wells, ditches and draining-pipe offer a good habitat for Gallionella. The bacterium grows rapidly at temperatures below 15 C and can form 25 micrometers thick biofilms within 48 hours in flowing water. Gallionella has been suggested to be chemolitotrophic. Structures were observed with electron microscopy that may be carboxysomes. Enrichment cultures of Gallionella were held in the laboratory on ferrous sulfide slant agar, covered by a salt solution infused with CO2. Growth experiments indicated that Gallionella is a free-living flagellated bacterium in the exponential phase. Reaching the retardation and stationary phase, Gallionella shifts to a stalked, sessile form. The mechanism behind this change is currently under study. The stable total cell number from the reference well water (averaging 258,000 cells/ml) can be explained if the aquifer area down in the well works as a continuous culture of swarmer cells. The amount of oxygen mixing from the well water surface controls the cell number, and the use of water regulates the growth rate. When the cells reach reservoirs and household pipes, the environment changes in an unfavorable way, stalk formation starts, and clogging problems begin. (See also W88-05724) (Lantz-PTT)
W88-05733

**MONITORING BIOFOULING,**
Krakow Technical Univ. (Poland).
For primary bibliographic entry see Field 7B.
W88-05735

**OXIDATION PROCESSES OF IRON IN GROUND WATER - CAUSES AND MEASURES,**
Stockholm Univ. (Sweden). Dept. of Geology.
For primary bibliographic entry see Field 5C.
W88-05739

**PERSISTENCE OF BIOLOGICALLY ACTIVE COMPOUNDS IN AQUATIC SYSTEMS,**
Wyoming Univ., Laramie.
For primary bibliographic entry see Field 5C.
W88-05747

**MIGRATION AND METHANOGENS - A REVIEW OF CURRENT LANDFILL GAS FIELD RESEARCH AT ANL,**
Argonne National Lab., IL.
J. Bogner, M. Torpy, C. Rose, M. Vogt, and D. Gartman.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-004836. Price codes: A03 in paper copy, A01 in microfiche. Report No. CONF-8610227--1, (1987). 26 p, 6 fig, 3 tab, 19 ref. DOE Contract No. W-31-109-Eng-38.

Descriptors: *Methanogens, *Research needs, *Landfills, *Waste disposal, *Water pollution sources, *Path of pollutants, Monitoring, Leachates, Microbiological studies, Soil bacteria, Waste management, Gas fields, Pilot plants.

Landfill gas recovery research at Argonne National Laboratory is focusing on: (1) a project studying gas movement through landfill cover materials; and (2) a pilot investigation of microbial population in landfills. The first project is a field investigation begun in 1984 at the Mallard North Landfill, Dupage County, Illinois, where vertical gas pressure and concentration gradients between the top of refuse and the landfill cover are being examined. In particular, changes in the vertical gradients indicative of changes in magnitude and direction of pressure or diffusional flow with time are being monitored. This study emphasizes changes in vertical pressure and concentration gradients related to barometric pressure and other meteorological variables, soil moisture changes, and pumping rates at simulated recovery wells. Preliminary results suggest that changes in soil-gas pressures in the landfill cover and top of refuse closely follow changes in barometric pressure. Measurable concentration gradients exist between the top of refuse and the cover materials, indicating that diffusion is a major mechanism for gas movement, particularly during dry weather when pressure gradients are negligible. The second project is a pilot investigation begun in 1986 on microbial populations in sanitary landfills. First, a series of leachate samples from various depths at the Blackwell Forest Preserve Landfill (also in Dupage County, Illinois) were evaluate for microbial populations, selected chemical constituents (including organic acids), and methane production. Diverse motile populations of fluorescing organisms were found in selected samples. Further evaluation of leachate sampling vs. substrate sampling is under way. The overall objective of this project is to improve understanding of gas production in landfills in order to suggest gas-production management practices. (Author's abstract)
W88-05748

**GEOCHEMISTRY OF URANIUM AND THORIUM SERIES NUCLIDES AND OF PLUTONIUM IN THE GULF OF MEXICO: FINAL REPORT,**
Texas A and M Univ., College Station. Dept. of Oceanography.
M. R. Scott.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-008358. Price codes: A02 in paper copy, A01 in microfiche. Report No. DOE/EV/03852--T1, (1987). 5 p, 9 ref. DOE Contract No. DE-AS05-76EV03852.

Descriptors: *Uranium, *Thorium, *Geochemistry, *Path of pollutants, *Plutonium, *Gulf of Mexico, Mississippi River, Iron, Manganese, Aluminum, Radioactivity, Nuclear fallout, Radioisotopes, Fate of pollutants, Tributaries, Lanthanum, Calcium carbonate.

This project was initially focused on the question of the transport of Pu by the Mississippi River and the subsequent fate of that material when it entered the ocean. In the early stages of the project, samples were collected from the Mississippi and its tributaries, and from other rivers spanning a gradation in climate from the arid Rio Grande region to the subtropical Suwannee River. Plutonium analyses of water and of suspended and bottom sediments were complimented with Fe, Mn, La, CaCO3, and organic matter measurements. Analyses of U and Th isotopes, 210-Pb, and 226-Ra were made to serve both as tracers for transport processes, and (for the reactive nuclides) as steady state chemical analogues for Pl. The contribution of fallout 239, 240-Pu to the ocean by the Mississippi River was found to be gradually decreasing over time. The distribution of 239, 249-Pu in river suspended sediment is related to the Mn/Al and Fe/Al ratios. Correlation coefficients of 0.95 or greater are found between Pu content and these metals. The study of the behavior of fallout Pu in the marine environment has resulted in the discovery of several important processes controlling Pu chemistry in the Gulf of Mexico as well as other parts of the ocean. The inventories of 239, 240-Pu in the sediments of the Mississippi Delta are up to seven times higher than predicted from vertical atmospheric fallout alone. Similar excess inventories are seen for 210-Pb excess in delta sediments. The large excess of Pu in the delta indicates the horizontal flux of large amounts of material from the open ocean to the particle-rich removal site at the delta. The ratio 240-Pu/239-Pu in delta sediments is about 0.179, the same value as stratospheric fallout, but the sediments from the deep Gulf of Mexico have ratios as low as 0.06. The low ratio material has probably been derived from low altitude tests at the Nevada Test Site, and delivered vertically to the sea floor much more quickly than the stratospheric component of Pu fallout. (Lantz-PTT)
W88-05750

**CONCENTRATIONS OF PCBS, DDTR, AND SELECTED METALS IN BIOTA FROM GUNTERSVILLE RESERVOIR,**
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
D. L. Dycus, and D. R. Lowery.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-900613. Price codes: A04 in paper copy, A01 in microfiche. Report No. TVA/ONRED/AWR--87/18, October 1986. 70 p, 2 fig, 12 tab, 2 ref, 2 append.

Descriptors: *Guntersville Reservoir, *Alabama, *Path of pollutants, *Monitoring, Biomonitoring, Tissue analysis, Shad, Catfish, Bass, Fish, Polychlorinated biphenyls, DDT, Chromium, Nickel, Mercury, Liver, Heavy metals, Environmental effects.

The Tennessee Valley Authority (TVA) and the Alabama Department of Environmental Management (ADEM) conducted a cooperative screening study in summer/fall 1985 to determine levels of contaminants in biota from Guntersville Reservoir. Catfish and largemouth bass were collected to determine if fish contained contaminants of human health significance. Gizzard shad and livers from catfish and snapping turtles were used as 'environmental monitors' to determine if contaminants existed in the aquatic system that have an effect on aquatic life but would otherwise go undetected. All samples were analyzed for PCBs, DDTr (total of DDT and its metabolites), and selected metals. Levels of PCBs, DDTr, and metals were low in largemouth bass at all locations indicating these fish should be safe for consumption. However, this study reinforced a need identified in other studies to further evaluate the size of largemouth bass from Guntersville Reservoir. Recommendations have been provided in the Guntersville Reservoir management plan; therefore, no specific recommendations are provided here. Catfish contained low levels of DDTr and metals except for Cr and Ni, which may have resulted from contamination during sample processing, and mercury, which needs further study at one location (Big Spring Creek). Also, further evaluation of PCB loading in catfish from Guntersville Reservoir is needed because levels near the FDA tolerance occurred throughout the reservoir. All samples should be analyzed for Cr and Ni to address that potential concern. All samples (those cited above plus those for whole gizzard shad, catfish livers, turtle livers, and turtle fat) had levels of metals that were generally low and probably not individually having a significant impact on biota. (Lantz-PTT)
W88-05752

**MULTI-SOLUTE SUBSURFACE TRANSPORT MODELING FOR ENERGY SOLID WASTES.**
Department of Energy, Washington, DC. Div. of Ecological Research.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-005182. Price codes: A06 in paper copy, A01 in microfiche. Report No. DOE/EV/10253--5, January 1987. Final Report. 177 p, 50 fig, 8 tab, 70 ref, append. DOE Contract No. DE-AC02-79EV10253.

Descriptors: *Path of pollutants, *Model studies, *Solute transport, *Solid wastes, *Groundwater movement, Mathematical models, Mathematical analysis, Leachates, Flow profiles, Algorithms, Sorption, Chemical reactions, Kinetics.

Progress on a research effort which has been directed toward the development and application of advanced subsurface solute transport models, is details. Leachates from energy wastes represent a potentially large problem and may become a significant transport pathway for objectionable constituents. The proposal of realistic solutions for the handling of these wastes requires a fundamental knowledge of the mechanisms involved. The major objective of the research has been to understand these important mechanisms and to gather this information, in the form of a subsurface hydrogeochemical transport model, for use in predictive, design and investigative purposes. The approach makes use of batch mechanistic and dynamic column experimental methods, and theoretical mathematical analysis. Many past and present subsurface solute transport models incorporate the combined effects of physical factors such as advection, dispersion and diffusion but frequently ignore the chemical interactions among solute species and soil surfaces. The emphasis of this research has been on the coupling of realistic chemical interactions, involving homogeneous and heterogeneous systems, with existing subsurface solute flow models. This report is divided into three sections. In Section II, the various numerical solution algorithms used are derived, examined, and compared for efficiency and accuracy. Section III deals with the important aspect of the instantaneous equilibrium assumption which is often used in subsurface transport simulations. Section IV reviews the results of laboratory sorption studies and contrasts methods for gathering equilibrium and kinetic data. (Lantz-PTT)
W88-05753

**EFFECTS OF CONSERVATION TILLAGE ON GROUNDWATER QUALITY: NITRATES AND PESTICIDES,**
Ohio State Univ., Columbus. Dept. of Soil Chemistry.
For primary bibliographic entry see Field 4C.
W88-05759

**OVERVIEW OF PEST MANAGEMENT FOR CONSERVATION TILLAGE SYSTEMS,**
Iowa State Univ., Ames.
R. S. Fawcett.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 19-37, 1 fig, 67 ref.

Descriptors: *Pesticides, *Conservation tillage, *Water pollution control, *Groundwater quality, Herbicides, Weeds, Erosion, Management planning, Agricultural practices, Corn, Soybeans, Plant pathogens, Insects.

Changes in tillage practices can significantly affect pest problems, thus changing pest management strategies and pesticide use. Concerns have been raised by some observers that a trade-off may occur with the adoption of conservation tillage. The beneficial result of reduced soil erosion with conservation tillage may come at the expense of increased pesticide use, which may increase water contamination potential. Addressed here are the implications of conservation tillage on weeds, insects, and plant pathogens and on projected changes in pesticide use. Greatest emphasis is placed on weeds, as extensive research has been conducted on the impact of tillage on weeds and herbicides, and herbicide use accounts for about 85% of total pesticide use in the United States. Corn and soybeans account for 80-85% of present herbicide use. (See also W88-05759) (Lantz-PTT)
W88-05761

**OVERVIEW OF NITROGEN MANAGEMENT FOR CONSERVATION TILLAGE SYSTEMS: AN OVERVIEW,**
Minnesota Univ. Technical Coll., Waseca.
For primary bibliographic entry see Field 4C.
W88-05762

**OVERVIEW OF RURAL NONPOINT POLLUTION IN THE LAKE ERIE BASIN,**
Heidelberg Coll., Tiffin, OH.
D. B. Baker.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 65-91, 5 fig, 10 tab, 25 ref.

Descriptors: *Nonpoint pollution sources, *Conservation tillage, *Lake Erie, *Agricultural practices, Agricultural runoff, Phosphorus, Sediment load, Fertilizers, Pesticides, Rural areas, Nutrients, Nitrates, Path of pollutants, Watersheds.

The tributary monitoring programs in the Lake Erie Basin indicate that area rivers transport large loads of sediments, and both particulate and soluble phosphorus, derived from agricultural sources. Agricultural runoff also results in riverine nitrate concentrations which frequently exceed drinking water standards. Relatively high concentrations of many currently used pesticides are also present in area streams and public water supplies during runoff events following pesticide application. Much discussion during this workshop has focused on the issues of whether various forms of conservation tillage would increase nitrate and pesticide contamination in surface water and groundwater. Given the extent of nitrate and pesticide contamination associated with current management practices in this region, present concerns should be not only that conservation tillage not aggravate these problems, but that comprehensive agricultural management programs be developed that will reduce nitrate, pesticide, and soluble phosphorus problems. Residue management must be accompanied by improved fertilizer and pesticide management if agricultural nonpoint source pollution problems in the Great Lakes Region are to be addressed. The Lake Erie tributary monitoring programs also illustrate the substantial effects of watershed size on the characteristics of agricultural pollution in stream and river systems. These studies suggest that as watershed size becomes smaller: (1) annual variability in material export increases; (2) peak concentrations of sediment, nutrients and pesticides increase; (3) the duration of intermediate concentrations of sediments, nutrients and pesticides decreases; (4) smaller proportions of time account for larger proportions of total material export; (5) more samples must be collected and analyzed in order to accurately measure material export; and (6) the seasonal distribution of stream sediment transport corresponds more closely to the seasonal distribution of erosion processes. (See also W88-05759) (Lantz-PTT)
W88-05763

**HYDROLOGIC EFFECTS OF CONSERVATION TILLAGE AND THEIR IMPORTANCE RELATIVE TO WATER QUALITY,**
Iowa State Univ., Ames.
For primary bibliographic entry see Field 4C.
W88-05765

**SOIL CHEMICAL AND BIOLOGICAL PROPERTIES AS AFFECTED BY CONSERVATION TILLAGE: ENVIRONMENTAL IMPLICATIONS,**
Ohio State Univ., Wooster. Agricultural Technical Inst.
For primary bibliographic entry see Field 4C.
W88-05766

**EFFECT OF CONSERVATION TILLAGE ON BIOLOGICAL AND CHEMICAL SOIL CONDITIONS: REGIONAL AND TEMPORAL VARIABILITY,**
Kentucky Univ., Lexington.
For primary bibliographic entry see Field 4C.
W88-05767

**EFFECTS OF CONSERVATION TILLAGE PRACTICES ON PESTICIDE VOLATILIZATION AND DEGRADATION,**
Agricultural Research Service, Beltsville, MD.
D. E. Glotfelty.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 169-177, 9 ref.

Descriptors: *Conservation tillage, *Pesticides, *Path of pollutants, *Volatilization, *Degradation, *Fate of pollutants, Microclimate, Great Lakes, Nonpoint pollution sources, Pollution load, Soil properties, Agricultural practices.

Conservation tillage changes soil properties, soil chemistry and the microclimate at the soil surface in ways that may profoundly affect the volatilization, degradation, and uptake of pesticides. One of the most significant changes that may accompany conversion to conservation tillage is in how the pesticide is managed. If a pesticide that is normally incorporated into the soil in a conventional tillage system is instead applied to the surface without incorporation in a no-till system, it is likely that a significant change in the rate and mechanisms of dissipation will occur. A second significant difference between conventional and no-till systems is the presence of the surface mulch that intercepts the pesticide spray and alters the microclimate at the soil surface. Other important differences include soil temperature, altered moisture content and distribution within the soil, and altered organic matter content and distribution within the soil. Changes in pesticide degradation rates and products are almost certain to accompany the very different conditions in no-till soils. Even small changes in degradation rates may be very important. One may conclude that volatilization is potentially much greater for some pesticides in no-till systems, resulting in both loss of efficacy and lower loading to waterborne transport. However, volatilized pesticides do return to the surface. Because of their relatively large ratio of surface area to watershed area, pesticide loading to the Great Lakes could conceivably increase following extensive adoption of no-till agriculture, because rainout and dry deposition of atmospheric pesticides could be greater than waterborne loading from conventional tillage agriculture. (See also W88-05759) (Lantz-PTT)
W88-05768

**EFFECT OF CONSERVATION TILLAGE ON PESTICIDE DISSIPATION,**
Agricultural Research Service, Beltsville, MD.
C. S. Helling.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 179-187, 2 fig, 2 tab, 21 ref.

Descriptors: *Conservation tillage, *Pesticides, *Fate of pollutants, *Path of pollutants, Volatilization, Dissipation, Atrazine, Agricultural practices, Degradation, Soil properties, Soil water, Hydrogen ion concentration, Soil bacteria.

Loss of pesticides from surface soil can occur by physical transport, degradation, or plant uptake. Persistence, a relative measurement of what proportion of the pesticide remains in soil after a period of time, is determined by how rapidly dissipation occurs. Persistence affects weed control, but excessive persistence may injure the next crop. As an example, atrazine carryover in a wheat-fallow-wheat rotation (where the fallow period is a form of conservation tillage used to replenish soil moisture) would be a major problem for farmers. The two major processes affecting persistence are, in general, volatilization and degradation. Pesticide dissipation changes that are caused by conservation tillage practices are of uncertain magnitude. Among reasons for this uncertainty are the wide range of tillage practices which, in turn, lead to differing impacts on soil physical and chemical properties. The extreme situation, no-till farming, can lead to higher organic matter content, cooler soil temperature, higher moisture content, lower pH, and greater microbial activity; these effects are most pronounced nearest the surface. Pesticide degradation is probably somewhat faster in no-till than in conventional tillage. (See also W88-05759) (Lantz-PTT)

W88-05769

**PROCESSES INFLUENCING PESTICIDE LOSS WITH WATER UNDER CONSERVATION TILLAGE,**
Cornell Univ., Ithaca, NY.
R. J. Wagenet.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 189-204, 2 fig, 1 tab, 34 ref.

Descriptors: *Fate of pollutants, *Pesticides, *Path of pollutants, *Leaching, *Conservation tillage, Agricultural practices, Soil water, Surface runoff, Soil contamination, Groundwater movement.

Adoption of conservation tillage practices usually implies increased reliance upon, although not necessarily increased usage of, pesticides, particularly the application of herbicides for weed control. The environmental fate of these chemicals is relatively unstudied under the particular physical, chemical and biological processes operative in conservation tillage (CT) systems, making it necessary to use information developed under conventional agricultural practices to infer appropriate management and regulatory decisions. It has only been during the last 3-5 years, during which time CT has been more widely promoted and accepted, that a few studies have attempted to quantify pesticide losses by water under this increasingly widespread practice. It is clear that the unique nature of such systems, including heavier pesticide applications, reduced mechanical manipulation of soil and crop residue, and altered water retention and flow properties will result in pesticide behavior that cannot necessarily be inferred from studies accomplished in conventional systems. (See also W88-05759) (Lantz-PTT)
W88-05770

**EFFECTS OF CONSERVATION TILLAGE ON PESTICIDE LOSS WITH WATER,**
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Center.
For primary bibliographic entry see Field 4C.
W88-05771

**EFFECT OF CONSERVATION TILLAGE ON FATE AND TRANSPORT OF NITROGEN,**
North Carolina State Univ., Raleigh.
For primary bibliographic entry see Field 4C.
W88-05772

**LOW-LEVEL RADIOACTIVE WASTE DISPOSAL,**
Vanderbilt Univ., Nashville, TN. Dept. of Environmental and Water Resources Engineering.
For primary bibliographic entry see Field 5E.
W88-05806

**LOW-LEVEL RADIOACTIVE WASTES IN THE NUCLEAR POWER INDUSTRY,**
Electric Power Research Inst., Palo Alto, CA. Low-Level Waste and Coolant Technology Program.
R. A. Shaw.
IN: Low-Level Radioactive Waste Regulation: Science, Politics and Fear. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 119-140, 7 fig, 3 tab, 9 ref.

Descriptors: *Low level radioactive waste, *Water pollution sources, *Nuclear powerplants, *Radioactive wastes, *Cooling water, Waste disposal, Path of pollutants, Filtration, Land disposal, Purification, Water pollution control.

Radioactivity is produced directly in nuclear power plants as a result of the energy-producing fission process. Radioactivity is formed indirectly in nuclear power plants through the production of neutrons in fission. These neutrons bombard other materials in the area, producing more radioactive nuclei that will similarly decay. The fragments formed directly from fission are generally contained within the fuel cladding. This fuel material, once it has been used within a nuclear power plant, becomes highly radioactive. The waste resulting from the disposal of such fuel is classified as high-level radioactive waste (HLRW). Except for the fuel, the radioactive wastes generated within the nuclear power plant are termed low-level radioactive wastes (LLRW). The primary source of such LLRW is the contaminants contained in the cooling water that is used to generate the steam in a nuclear power plant. The purification and filtration of the reactor coolant removes these contaminants. These contaminants include both nonradioactive and radioactive species. These filtration and purification processes are a significant source of LLRW - e.g., spent filters - in nuclear power plants. The Electric Power Research Institute states that the basic function of any radwaste (radioactive waste) system is to: (1) minimize the release of gaseous radwaste to the environs through delay and filtering; (2) Minimize the release of liquid radwaste to the environs by purifying or reclaiming plant waste water; and (3) Minimize the impact of shallow land disposal by producing a solid waste product which is in compliance with federal criteria. (See also W88-05805) (Lantz-PTT)
W88-05807

**SAFER THAN SLEEPING WITH YOUR SPOUSE - THE WEST VALLEY EXPERIENCE,**
New York State Dept. of Health, Albany.
For primary bibliographic entry see Field 5E.
W88-05808

**FATE AND BIOACCUMULATION OF SOIL-ASSOCIATED LOW-LEVEL NATURALLY OCCURRING RADIOACTIVITY FOLLOWING DISPOSAL INTO A MARINE ECOSYSTEM,**
Rhode Island Univ., Narragansett. Marine Ecosystems Research Lab.
C. D. Hunt.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-204822. Price codes: A06 in paper copy, A01 in microfiche. EPA Report No. EPA-520/1-86-017, October 1, 1986. 155 p, 61 fig, 22 tab, 36 ref, 7 append. Contract No. CR-810265-02.

Descriptors: *Path of pollutants, *Fate of pollutants, *Marine environment, *Bioaccumulation, *Ecosystems, *Low-level radioactivity, *Radium, Marine dumping, Lead, Polonium, Thorium, Radioisotopes, Tissue analysis, Zooplankton, Mussels, Bivalves, Bioconcentration.

The fate of Radium (Ra) and other naturally occurring Uranium (U) series isotopes associated with soils disposed in seawater was examined using the Marine Ecosystem Research Laboratory (MERL) controlled marine ecosystems. Thirty-seven kg of a soil containing approximately 400 pCi 226-Ra/g from an inactive U ore processing plant site in Middlesex, N.J. were added to each of two mesocosms over five days in mid-September 1984. Radionuclide activity in these and two control mesocosms was observed for three months after the soil additions. Radioactivity in the soil appeared to be confined to discrete soil particles rather than being distributed equally on the soil particles, suggesting the source of the radioactivity was remnant ore particles. Immediately following the additions, 0.2 to 1.5% of the added radioactivity (depending on nuclide) was found in plant detritus that floated to the water surface. Ten percent of the added Ra was found in the water column within three days of soil additions and an additional 5% mobilized to the water column during the subsequent 90 days. Longer term mobilization of Ra from the sediments was confirmed by benthic flux changers. U isotopes showed similar release on contact with seawater, while $< 1\%$ of the lead (Pb)-210, polonium (Po)-210, and thorium (Th) series isotopes were released immediately after the additions. Long term release of nuclides other than Ra could not be determined due to insufficient data from the water column over the course of the experiment. Of the Ra mobilized, more than 97% was found in the dissolved phase. Increases in Ra and other isotope activity in the sediments were confined to the surface 1 cm initially, and penetrated to approximately 2 cm by the termination of the experiment as a result of bioturbation and settling processes. Little effect on the ecosystem structure and function are found from the soil additions. At the species level, bioaccumulation of Ra and other radionuclides was observed in all species sampled, including zooplankton and benthic species in direct contact with the soil. (Lantz-PTT)
W88-05850

**REGIONAL DOUBLE-POROSITY SOLUTE TRANSPORT IN THE CULEBRA DOLOMITE: AN ANALYSIS OF PARAMETER SENSITIVITY AND IMPORTANCE AT THE WASTE ISOLATION PILOT PLANT (WIPP) SITE,**
INTERA Technologies, Inc., Austin, TX.
M. Reeves, V. A. Kelley, and J. F. Pickens.
Available from the National Technical Information Service, Springfield, VA. 22161 as DE88-004730. Price codes: A08 in paper copy; A01 in microfiche. Sandia National Laboratory Contractor Report No. SAND87-7105, November 1987. 177 p, 39 fig, 11 tab, 52 ref, 3 append. Contract No. DE-AC04-76DP00789.

Descriptors: *Path of pollutants, *Solute transport, *Culebra Dolomite, *Waste Isolation Pilot Plant, *Groundwater movement, *Geohydrology, Transmissivity, Model studies, Flow rate, Kinetics, Traveltime, New Mexico, Simulation analysis, Geologic fractures, Diffusion, Wastewater facilities, Computer programs, Pilot plants.

A high-transmissivity fracture-controlled path is assumed, for modeling purposes, to provide the means for transport of infinitely long-lived radionuclides through the Culebra dolomite (New Mexico) to the accessible environment at the Waste Isolation Pilot Plant (WIPP) site, following a breach which does not disturb the existing head potentials within the unit. Both matrix diffusion and sorption retard the transport. Parameter ranges and base-case values depict the uncertain properties of the Culebra while simulations with SWIFT II exhibit the corresponding ranges in travel time, the performance measure adopted for this report. Consistent with the paucity of the double-porosity data base, model assumptions are kept simple and parameter ranges relatively large. Thus, computed travel times may be unrealistic and should not be quoted apart from the model assumptions. Computed parameter sensitivities and estimated parameter importance, however, should provide valuable guidance to the current site-characterization program at the WIPP site. The report demonstrates the importance of the rate of fluid flow within the fractures and the relative unimportance of some of the matrix kinetic parameters which relate to the matrix-diffusion time. The report underscores the importance of hydraulic and tracer tests, particularly in the southeast sector of the WIPP site. Such tests would further confirm the flow and transport conceptualization, determine the extent of site heterogeneity, and reduce uncertainty in the transport properties. (Author's abstract)
W88-05852

**USE OF MULTIVARIATE METHODS IN THE INTERPRETATION OF WATER QUALITY MONITORING DATA OF A LARGE NORTHERN RESERVOIR,**
For primary bibliographic entry see Field 7C.
W88-05865

**MODELING RIVER ACIDITY - A TRANSFER FUNCTION APPROACH,**
Norsk Regnesentral, Oslo.
For primary bibliographic entry see Field 7C.
W88-05866

**DETERMINATION OF WATER QUALITY ZONATION IN LAKE ONTARIO USING MULTIVARIATE TECHNIQUES,**
Inland Waters Directorate, Burlington (Ontario). Water Quality Branch.
For primary bibliographic entry see Field 7C.
W88-05870

**SPATIAL VARIABILITY IN THE WATER QUALITY OF QUEBEC RIVERS,**
Quebec Ministere de l'Environnement, Sainte-Foy.
For primary bibliographic entry see Field 7C.
W88-05871

**SOME APPLICATIONS OF LINEAR MODELS FOR ANALYSIS OF CONTAMINANTS IN AQUATIC BIOTA,**
University of Western Ontario, London.
For primary bibliographic entry see Field 7C.
W88-05879

**GAMMA MARKOV PROCESSES,**
Monash Univ., Clayton (Australia).
For primary bibliographic entry see Field 7C.
W88-05883

**DYNAMIC COVARIATE ADJUSTMENT OF WATER QUALITY PARAMETERS FOR STREAMFLOW: TRANSFER FUNCTION MODEL SELECTION,**
Vermont Univ., Burlington.
For primary bibliographic entry see Field 7C.
W88-05884

**GLOBAL VARIANCE AND ROOT MEAN SQUARE ERROR ASSOCIATED WITH LINEAR INTERPOLATION OF A MARKOVIAN TIME-SERIES,**
Quebec Univ., Sainte-Foy.
For primary bibliographic entry see Field 7C.
W88-05887

**ESTIMATION OF LOADING BY NUMERICAL INTEGRATION,**
A. H. El-Shaarawi, K. W. Kuntz, and A. Sylvestre.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 469-478, 2 tab, 5 ref.

Descriptors: *Pollutant load, *Water quality, *Mathematical studies, *Data interpretation, *Niagara River, *Lake Ontario, Statistical analysis.

Methods based on numerical integration and linear interpolation were used to derive an estimator of the input loading from a river or a point source into a water system. The variance of the estimated loading is also given. This approach was then applied to estimate the yearly chloride loading to Lake Ontario by the Niagara River during the period 1975 to 1984. The results indicate a steady decline in input loading of chloride to Lake Ontario. (See also W88-05862) (Author's abstract)
W88-05897

**PROCESSES AFFECTING SUBSURFACE TRANSPORT OF LEAKING UNDERGROUND TANK FLUIDS,**
Nevada Univ., Reno. Desert Research Inst.
S. W. Tyler, M. R. Whitbeck, M. W. Kirk, J. W. Hess, and L. G. Everett.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-201521. Price codes: A04 in paper copy, A01 in microfiche. EPA Report No. EPA/600/6-87/005, June 1987. 77 p. Contract No. CR 810052.

Descriptors: *Fate of pollutants, *Path of pollutants, *Leakage, *Underground storage, Water pollution control, Monitoring, Soil properties, Adsorption.

The fundamental theories and an understanding of the processes controlling migration and fate in the subsurface of material released from an underground storage tank are presented. Processes affecting the migration of fluids from a leaking underground storage tank and their effects on monitoring methods are reviewed by experts. An understanding of these processes is critical to an understanding of the methods that monitor underground storage tanks in the environment surrounding the tank for material released from the tank. Soil heterogeneities and the potential for multiphase flow will lead to high monitoring uncertainties if leak detection systems rely on liquid sampling alone. Vapor transport is also affected by these properties although to a lesser degree. More research is needed, however, to better understand the physics of vapor transport. The processes of adsorption, partitioning, and microbial alteration of fluids in the subsurface may have strong effects on the uncertainty of monitoring systems. Fate processes have received less attention than liquid and vapor transport processes and will require significantly more research before the effects are fully understood. (See W88-05902 thru W88-05917) (Author's abstract)
W88-05901

**LIQUID TRANSPORT FROM UNDERGROUND STORAGE TANKS,**
Kaman Tempo, Santa Barbara, CA.
L. G. Everett.
IN: Processes Affecting Subsurface Transport of Leaking Underground Tank Fluids. EPA Report No. EPA/600/6-87/005, June 1987. p 7-33, 14 fig, 49 ref.

Descriptors: *Path of pollutants, *Leakage, *Underground storage, *Soil properties, Monitoring, Regulations, Hazardous wastes, Hydrocarbons, Biodegradation, Absorption.

Although the Underground Storage Tank Permit System of the EPA covers liquid inorganic chemicals, natural mineral organics and synthesized chemical organic liquids stored in hazardous waste tanks, the largest number of tanks by far are fuel storage tanks. It is estimated that California alone has over 220,000 underground storage tanks in place today. When viewed across the nation, the magnitude of the monitoring requirements are considerable. Organic and inorganic liquid flow is discussed in relation to monitoring in the subsurface. The discussion of liquid hazardous waste migration, which occurs as a continuous multiphase flow under the influence of capillary, viscous, and gravity forces, includes an appreciation of both unsaturated and saturated flow regimes. The movement of a separate liquid hydrocarbon phase in a water and sometimes in air filled porous soil and the movement of organically active dissolved hydrocarbon components that are subject to biodegradation, absorption onto soil particles, and volatilization are very complex. Neither of these major transport mechanisms is well understood. While the dissolved component mechanism is the subject of intense study, the liquid phase transport mechanism has been virtually ignored by the U.S. research community. The vadose zone and saturated zone flow and transport are discussed, with a general discussion of general flow regimes. (See also W88-05901) (Lantz-PTT)
W88-05902

**VAPOR TRANSPORT AND ITS IMPLICATIONS TO UNDERGROUND TANKS,**
Arizona State Univ., Tempe. Dept. of Civil Engineering.
D. K. Kreamer.
IN: Processes Affecting Subsurface Transport of Leaking Underground Tank Fluids. EPA Report No. EPA/600/6-87/005, June 1987. p 34-52, 3 fig, 13 ref.

Descriptors: *Path of pollutants, *Vaporization, *Underground storage, Leaking, Monitoring, Aeration zone, Geologic fractures.

In the underground storage tank environment, gaseous movement can be a significant component of overall migration of leaked product, particularly if that product is highly volatile. Movement of compounds in the vapor phase through advection or diffusion or both processes can and often does occur in all directions from a leak source. Therefore, a portion of volatile, leaked product vapor could migrate in a direction opposite of the underlying groundwater flow. The vapor could then enter the groundwater system by redissolving across the capillary fringe and water table and could appear to be liquid pollutant moving up the hydraulic gradient. This outward flux of gases in the unsaturated zone has important implications to leak detection. A gaseous phase detector would be less likely to 'miss' a gas moving radially outward, than a monitoring well attempting to detect a finite plume moving down the hydraulic gradient in the aqueous phase. Because vapor phase monitors are normally emplaced at shallower depths than aqueous phase samplers, there is some emplacement cost saving with vapor detection systems in the unsaturated zone. Several factors, such as background contamination and geologic stratification, can have a negative effect on leak detection in the vapor phase, but monitoring of gases in unsaturated porous media, while not perfect, has been shown to be a useful tool if interpreted correctly. Recent legislation in the State of California has recognized the value of gaseous monitoring and has opened the way for its use in situations of contamination. Vapor transport surrounding underground storage tanks, naturally-occurring and man-made gases in the subsurface, mechanisms of transport with particular attention to transport in the underground tank environment, existing types of vapor monitoring methodologies, requirements and shortcomings of present vapor detection systems and theory, and future directions of vapor-leak monitoring, are all discussed in this paper. (See also W88-05901) (Lantz-PTT)
W88-05903

**SOIL SURFACE AND INTERFACIAL EFFECTS IN THE UNDERGROUND STORAGE TANK ENVIRONMENT,**
Nevada Univ., Reno. Desert Research Inst.
M. R. Whitbeck, and M. W. Kirk.
IN: Processes Affecting Subsurface Transport of Leaking Underground Tank Fluids. EPA Report No. EPA/600/6-87/005, June 1987. p 53-60, 12 ref.

Descriptors: *Path of pollutants, *Soil properties, *Underground storage, *Monitoring, *Leaking, Physical properties, Chemical properties, Conductivity, Refractive index, Absorption, Spectrophotometry, Solute transport, Biodegradation.

The detection of contaminants leaking from underground storage tanks or monitoring such tanks for leaks in the underground environment is dependent on the physical and chemical properties of the contaminants that might be sensed by chemical instrumentation. Properties of the leaking contaminant or its degradation products that may be of use include: refractive index; thermal conductivity; acoustic conductivity; electrical conductivity; ultraviolet, visible, or infrared absorbance spectra; fluorescence spectra; or electrochemical oxidation/reduction potentials. These properties may be profoundly affected by the physical chemistry of the contaminants at interfaces. Adsorption and partitioning between available phases are the more notable of these interfacial phenomena. The adsorption-desorption of contaminants with soil particles, distribution between immiscible phases, and emulsification constitute important parameters in: pollutant transport kinetics; bioavailability; chemical degradation; and the properties given previously. The leaking chemicals may modify the physical and chemical properties of the surrounding fill material. Adsorption of aromatic hydrocarbons, for example, can distort the interatomic distances in clays and, subsequently, can greatly affect the porosity and permeability. The evaluation of the myriad of possible effects in the environment of leaking underground storage tanks may seem at first to be a desirable undertaking. Evaluation of their individual and collective impact on those properties, such as transport, are important in leak detection strategies. The use of numerical models permits a convenient means to estimate the impact of these phenomena collectively and individually and also to estimate their relative importance under specified conditions. (See also W88-05901) (Lantz-PTT)
W88-05904

**IMPLICATIONS OF SUBSURFACE BIOLOGICAL ACTIVITY FOR MONITORING UNDERGROUND STORAGE TANKS,**
Robert S. Kerr Environmental Research Lab.,

Ada, OK.
For primary bibliographic entry see Field 5A.
W88-05905

GROUNDWATER MODELLING: AN INTRODUCTION WITH SAMPLE PROGRAMS IN BASIC,
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 2F.
W88-05908

DEVELOPMENT AND APPLICATION OF TECHNIQUES FOR PREDICTING LEACHATE QUALITY IN CONFINED DISPOSAL FACILITIES: BACKGROUND AND THEORY,
Mississippi State Univ., Mississippi State. Dept. of Chemical Engineering.
D. O. Hill, T. E. Myers, and J. M. Brannon.
Available from the National Technical Information Service, Springfield, VA. 22161. Miscellaneous Paper D-88-1, February 1988. Final Report. 74 p, 11 fig, 1 tab, 66 ref, 4 append.

Descriptors: *Landfills, *Groundwater pollution, *Leachates, *Waste disposal, *Disposal sites, *Path of pollutants, Dredging, Mathematical studies, Leaching, Chemical properties, Physical properties, Groundwater movement.

A theoretical framework for predicting leachate quality in confined disposal facilities was developed using mass transport theory. The physical-chemical processes governing leaching were identified and described mathematically. Various approaches to describing contaminant transfer from the dredged material solids to the aqueous phase were considered, including equilibrium concepts, dissolution kinetics, intraparticle diffusion, and film effects. The approach recommended for application to dredged material uses an operationally defined distribution (partitioning) coefficient to relate aqueous phase concentration to solid phase concentration. This approach assumes equilibrium within the dredged material between solid and aqueous phases. The equilibrium approach assumes that interphase transfer kinetics are fast compared to the percolation rate of water through dredged material. The theoretical analysis was used to design laboratory tests for determining the leaching characteristics of dredged material. A sequential batch leach test is recommended for obtaining distribution coefficients, and a pressurized column test using divided-flow (double-ring) permeameters is recommended as a physical model of reduced scale for verifying the distribution coefficients obtained in batch tests. The design concepts for the laboratory tests are preliminary, and additional evaluation on the basis of actual test results will be needed before the procedures recommended can be adopted. (Author's abstract)
W88-05910

## 5C. Effects Of Pollution

OCCURRENCE OF BACTERIAL RESISTANCE TO ARSENITE, COPPER, AND SELENITE IN ADVERSE HABITATS,
Wright State Univ., Dayton, OH. Dept. of Biological Sciences.
G. A. Burton.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 990-997, 1987. 1 tab, 17 ref.

Descriptors: *Pollutant identification, *Water pollution effects, *Heavy metals, *Arsenites, *Copper, *Selenites, *Bacterial resistance, Metals, Bacteria, Resistance, Sediments.

Elevated levels of arsenic, copper, and selenium have caused environmental impacts which are linked to agricultural, industrial, and municipal activities. The impacts of these metalloid/metals on natural microbial communities and the levels of resistance are poorly defined. The incidence of aerobic heterotrophic bacterial resistance to arsenite, selenite and copper in a variety of habitats in the United States is reported. These included soil, water, and sediments with known copper, arsenic, or selenium pollution, as well as control sites. Samples were collected from 33 sites within 13 ecosystems. The survey consisted of one soil, nine water, and twenty-seven sediment samples. A wide range of total recoverable metal concentrations was found among the test site sediments. Selenium levels ranged from 14.4 microgram/g dry wt on the Clark Fork River to less than 0.005 microgram/g at Volta Reservoir. Arsenic sediment concentrations ranged from 218.8 microgram/g at Station 4 on the Clark Fork River to 0.782 microgram/g at Station 10. Total copper results revealed extreme contamination at 1,078.1 microgram/g at Station 4 on the Clark Fork River and a low of 0.38 microgram/g in Bear Lake in Rocky Mountain National Park. Aerobic heterotrophic bacterial densities were at levels previously reported in waters and sediments. The portion of these bacterial populations which were resistant to selenite (10 mM) and copper (1 mM) showed marked differences between sites. The greatest range in resistance levels occurred with the metalloid, selenite. (Alexander-PTT)
W88-05110

DECREASED SURVIVAL AND TERATOGENESIS DURING LABORATORY SELENIUM EXPOSURES TO BLUEGILL, LEPOMIS MACROCHIRUS,
Carolina Power and Light Co., New Hill, NC. Harris Energy and Environmental Center.
S. E. Woock, W. R. Garrett, W. E. Partin, and W. T. Bryson.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 998-1005, 1987. 1 fig, 3 tab, 15 ref.

Descriptors: *Water pollution effects, *Bluegill, *Selenium, *Heavy metals, *Teratogenesis, *Survival, Population exposure, Metals, Fish, Mortality, Larvae.

For larval bluegill, parental elevated dietary selenium exposure causes teratogenesis and decreases larval survival. Parental dietary organoselenium is more toxic than dietary inorganic selenium. The combination of parental dietary, plus waterborne exposure, is more toxic than dietary exposure alone. Effects of chronic selenium exposure on the parent bluegill are summarized. Final, cumulative mortalities were not significantly different in the 30 microgram/g selenomethionine(SeMet) and selenite(Se4+) treatments but significantly exceeded those seen in the lower exposure concentrations. Mortalities began first in the 30 microgram/g Se4+ group, then increased rapidly in both 30 microgram/g treatments after 120 d and diminished after 200 d. Dying fish often, but not always, exhibited clinical symptoms including food aversion, edema, lethargy, melanmism, tetany, and erratic, spiral, or circular swimming. These signs were also noted occasionally in fish receiving the 13 microgram Se/g diets. Parental selenium exposure significantly affected mean larval survival, whereas percent hatch was not significantly affected. At comparable levels in the parents' diet, SeMet was more toxic to the larvae than Se4+. None of the larvae from parents that were fed the SeMet diet at 30 microgram Se/g swam up, while, on average, 75% of larvae from parents fed the 30 microgram/g Se4+ diet survived. A much greater decrease in mean larval survival occurred between 13 and 30 microgram/g of the SeMet diet compared with the decrease between 13 and 30 microgram/g of the Se4+ diet. Also, except for the 30 microgram/g SeMet treatment, variability of larval survival was great among individual spawns. Essentially all larvae that did not swim up in the other treatments, but were alive at the time swim-up counts were made, exhibited one or more terata. The number of multiple terata in individual larva generally decreased with decreased selenium concentration in the parents' diet. Usually less than 5% of the larvae that swam up had deformities, with no apparent differences among treatments. (Alexander-PTT)
W88-05111

CHANGES IN SELECTED BIOCHEMICAL PARAMETERS IN THE KIDNEY AND BLOOD OF THE FISH, TILAPIA MOSSAMBICA (PETERS), EXPOSED TO HEPTACHLOR,
Sri Venkateswara Univ., Tirupati (India). Dept. of Zoology.
V. Radhaiah, M. Girija, and K. J. Rao.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 1006-1011, 1987. 2 tab, 18 ref.

Descriptors: *Water pollution effects, *Tilapia, *Heptachlor, *Chlorinated hydrocarbons, *Pesticides, *Tissue analysis, Kidney, Blood, Carbohydrates, Population exposure, Fish, Biochemistry, Amino acids.

An attempt has been made to observe biochemical parameters of fish, Tilapia mossambica under heptachlor intoxication. Fish T were collected from the ponds near Tirupati, India. Decreased carbohydrate content in heptachlor intoxicated fish may be due to the rapid utilization of carbohydrates by the tissue, possibly to overcome the pesticide induced stress. Decreased protein content in the kidney could possibly be due to protein breakdown leading to increased amino acid pool of tissue. Increased levels of total lipid content suggest that lipogenesis occurs under pesticidal intoxication. The observed increase of amino acids may be due to decreased utilization of amino acids from other sources such as glucose and fatty acids and constant breakdown of proteins, as is also noticed in different organisms exposed to various pesticides. Blood parameters, such as urea, non-protein nitrogen and creatine have shown consistent increase under heptachlor impact which may possibly be attributed to the failure of clearance in kidneys with pathological lesions. (Alexander-PTT)
W88-05112

ACUTE TOXICITY OF TRIBUTYLTIN CHLORIDE TO EMBRYOS AND LARVAE OF TWO BIVALVE MOLLUSKS, CRASSOSTREA VIRGINICA AND MERCENARIA MERCENARIA,
Virginia Inst. of Marine Science, Gloucester Point.
M. H. Roberts.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 1012-1019, 1987. 2 tab, 19 ref.

Descriptors: *Tributyltin chloride, *Mollusks, *Embryos, *Larvae, *Water pollution effects, Toxicity, Population exposure, Mortality, Bioassay, Organic compounds.

A study was conducted to verify previously obtained results on the effects of Mercenaria mercenaria larvae, to extend the observations to fertilized clam embryos and to determine the acute toxicity of tributyltin oxide (TBTO) to embryos and larvae of the native oyster, Crassostrea virginica. Clams were obtained from two sources; one group was purchased from Biosphere, Inc. and a second group was collected locally from the York River, VA. Oysters were collected variously from the James and Rappahannock Rivers, VA. Brood stocks of both species were conditioned by maintaining them in heated flowing York River water supplemented with cultured algae until they developed ripe gametes and then held at 19-20 deg C until spawned. Tests with both stages of oyster and clam larvae were performed using a static replacement procedure. The 48-h LC50 for clam embryos was 1.13 microgram/L and that for oyster embryos was 1.30 microgram/L (0.71 ug/L with acetone carrier). There was no marked difference between survivorship in diluent and solvent controls for either species. The maximum exposure concentration was insufficient to produce a 24-h LC50 in embryo tests with either species, i.e. the 24-h LC50 exceeded 1.3 microgram/L. Clam embryo development was delayed at some TBT doses below the measured 48-h LC50. At 0.77 microgram/L, development to straight-hinge was recognizably delayed. Oyster embryos, in addition to a slight delay in development at high doses, also exhibited abnormal shell development. All surviving larvae developed into straight-hinge larvae during the test. However, at 0.77 microgram TBT/L and above, some larvae developed shells which were flattened rather than convex resulting in inability of larva to withdraw all meat and velum

into the shell. Clam and oyster larvae were slightly more tolerant of TBT than embryos. The 24-h LC50 exceeded 4.1 microgram/L in both cases. The 48-h LC50 was 1.65 microgram/L for clam larvae and 3.96 microgram/L for oyster larvae. There was no obvious flattening of valves of oyster larvae which already had well formed valves at the start of the experiment. Some subtle changes in shell shape were observed at the two highest doses including a notching of the valves opposite the hinge line. (Alexander-PTT)
W88-05113

**HEAVY METAL TOXICITY TO FIDDLER CRABS, UCA ANNULIPES LATREILLE AND UCA TRIANGULARIS (MILNE EDWARDS): TOLERANCE TO COPPER, MERCURY, CADMIUM, AND ZINC,**
Andhra Univ., Waltair (India). Dept. of Zoology.
V. U. Devi.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 1020-1027, 1987. 3 tab, 18 ref.

Descriptors: *Heavy metals, *Crabs, *Copper, *Mercury, *Cadmium, *Zinc, *Water pollution effects, Toxicity, Population exposure, Mortality, Bioassay, Effluents, India.

Fiddler crabs Uca annulipes(UA) and Uca triangularis(UT) were selected as bioassay organisms to study their tolerance to four heavy metals, copper, cadmium, zinc and mercury. UA and UT were collected from two localities: Visakhapatnam harbor and Bhimilipatnam both on the east coast of India. Visakhapatnam harbor is highly polluted, receiving industrial effluents and city's sewage. There was a difference in the sensitivity of crabs from the two regions, i.e., Harbor area (polluted) and Bhimilipatnam (unpolluted) when they were exposed to Cu, Cd, Zn and Hg. The lethal concentrations were higher for UA and UT of Harbor area than their counterparts in Bhimilipatnam which is explained by the fact that the Harbor water contains greater amounts of heavy metals accumulated from the industrial effluents. The brackish water of Bhimilipatnam does not show much heavy metal pollution. The Hg concentrations of water at both the stations are yet to be reported. The lethal concentration values decreased with exposure time for both species of crabs from the two stations. This investigation demonstrates that the habitat where the collections were made plays an important role in addition to the experimental conditions before a bioassay experiment is designed. Of the four metals tested, Hg was most toxic. The LC50 values of Hg for 96 h and 48 h observed for UA and UT of Bhimilipatnam area compare well with other crustaceans except Crangon crangon(CC) whose LC50 value for 48 h is nearer to those of UA and UT of Harbor area. Copper was more toxic than mercury for the fiddler crabs. The LC50 values of Cu for both the fiddler crabs of Harbor area and Bhimilipatnam appear to be not as high as reported for Carcinus maenus(CM) and Pandalus montagui(PM) but higher than for other crustaceans. Cadmium was less toxic than Hg and Cu but more toxic than Zn. (Alexander-PTT)
W88-05114

**ACUTE TOXICITY OF ROUNDUP AND RODEO HERBICIDES TO RAINBOW TROUT, CHINOOK, AND COHO SALMON,**
E.V.S. Consultants Ltd., North Vancouver (British Columbia).
D. G. Mitchell, P. M. Chapman, and T. J. Long.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 1028-1035, 1987. 3 tab, 5 ref.

Descriptors: *Rodeo, *Roundup, *Herbicides, *Trout, *Chinook, *Salmon, *Water pollution effects, Toxicity, Population exposure, Mortality, Bioassay, Organic compounds.

The results of aquatic toxicity testing of Rodeo and Roundup herbicides using three different fish species, different sized fish, and differences in dilution water (type/source, pH, hardness and conductivity) are summarized. There was no significant difference ($P<0.05$) in the toxicity of Roundup herbicide to 0.37 g rainbow trout, 4.6 g chinook salmon and 11.8 g coho salmon. Acute toxicity values ranges from 7.4 mg/L to 12 mg/L in terms of the IPA salt of glyphosate, with 95% confidence limits ranging from 5.7 - 18 mg/L. Varying dilution water type (dechlorinated, dechlorinated and reconstituted, and natural lake water), pH (range 6.1-7.7), hardness (4.5 - 85 mg/L as CaCO3) and conductivity (12 -132 micro-mhos/cm) did not significantly affect Roundup toxicity to 0.37 g rainbow trout. No significant differences ($P<0.05$) were found between the Rodeo/X-77 acute toxicity values for rainbow trout, chinook salmon, and coho salmon. The 96-h LC50 values ranged from 120 mg/L to 290 mg/L in terms of the IPA salt of glyphosate, with 95% confidence limits ranging from 68-380 mg/L. There was some indication that the use of waters with relatively high pH, hardness and conductivity values resulted in a decrease in Rodeo/X-77 toxicity (maximum values studied were pH 7.8, 77 mg/L and 130 micro-mhos/cm, respectively). However, these toxicity differences were not significant. Fish size also did not significantly ($P<0.05$) affect Rodeo/X-77 toxicity; test fish mean size ranged from 0.21 g for the rainbow trout to 17.9 g for the coho salmon. According to a toxicity classification scheme currently in use, Roundup and Rodeo herbicides would be considered slightly toxic and practically non-toxic, respectively, to trout and salmon species. No acute toxicity hazard to aquatic environments would be expected during the course of normal usage. (Alexander-PTT)
W88-05115

**ACUTE TOXICITY OF SYNTHETIC DETERGENTS TO SNAILS: EFFECT OF SODIUM LAURYL SULFATE ON LIMNAEA PEREGRA SHELLS,**
Instituto Nacional de Investigaciones Agrarias, Madrid (Spain). Centro de Investigacion y Tecnologia.
J. V. Tarazona, and O. Nunez.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 1036-1040, 1987. 3 fig, 2 tab, 16 ref.

Descriptors: *Sodium lauryl sulfate, *Detergents, *Snails, *Water pollution effects, Toxicity, Population exposure, Mortality, Bioassay, Calcium, Shells, Surfactants.

The effects of the anionic surfactant sodium lauryl sulfate (SLS) on the chemical composition and macroscopic aspect of shells of Limnaea peregra exposed to different concentrations of the surfactant were studied. One hundred laboratory cultivated L. peregra were acclimatized to water quality conditions for 72 h. They were 3 months old and weighed 0.1-0.2 g. During the acclimatization they were fed with an algal (i.e. Chlorella s.p.) diet. During the bioassay, shell discoloration and holes were observed on snails exposed to SLS. Discoloration was observed on all SLS treated animals, but holes were observed only in snails exposed to high concentrations. Exposure to SLS caused a decrease of shell dry weight due to a decrease in its inorganic components. This decrease depends on the logarithm of SLS concentration. Because discoloration and holes were observed in live animals, the shell's inorganic matter loss was measured for live animals. The decrease in inorganic matter due to SLS can be explained in two ways: (1) a direct effect on formation or loss of the shell's inorganic matter. The primary inorganic component in molusca shells in CaCO3; and (2) an effect on epithelium and cells that play an important role in the shell's formation and maintenance. This kind of physiological alteration should lead to a dose-dependent diminution of the capability of L. peregra to maintain the shell's calcium. (Alexander-PTT)
W88-05116

**DETERMINATION OF GROWTH RATE DEPRESSION OF SOME GREEN ALGAE BY ATRAZINE,**
Iowa State Univ., Ames. Dept. of Botany.
C. M. Hersh, and W. G. Crumpton.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 6, p 1041-1048, 1987. 1 fig, 2 tab, 14 ref. Iowa State WRRI Project Numbers G-906-05 and G-1017-05.

Descriptors: *Growth rates, *Algae, *Atrazine, *Pesticides, *Bioassay, *Water pollution effects, Toxicity, Population exposure, Mortality, Sediments, Organic compounds, Toxicity.

Algae from two different Iowa springs were used to study naturally occurring atrazine tolerance. The results of two aspects of that study are reported: development of a quick method of assessing toxic effects on algal growth, and investigation of an ecologically meaningful endpoint for experiments. Samples of water and surficial sediments were taken from Big Spring, Clayton County, Iowa and Osage Spring, Mitchell County, Iowa, on 21 August 1985. Each isolate was grown in the modified medium with atrazine additions to assess the effect of atrazine on growth rate. Eight clonal cultures (order Chlorococcales), were isolated from the samples. The Big Spring samples yielded four isolates (BSC), as did the Osage Spring samples (OSA). Wall growth was apparent in four of the eight field isolates. Based on a comparison with the appropriate control growth rate, the BSC and OSA isolates along with Chlamydomonas reinhardii 2137 mt+ exhibited low tolerance to atrazine, although the response was not the same for each isolate. Ar 204, the C. reinhardii atrazine resistant mutant showed little inhibition by even 2160 microgram/L atrazine. Because of possible effects on algal community structure and seasonal succession, a depression of growth rate at any concentration of a toxin should be considered environmentally meaningful. Effects may be detected at concentrations that are low and environmentally realistic. Concentrations higher than the lowest concentration used in these assays (21.6 microgram/L) have been reported for surface waters in North America. Determinations of toxicity that are based on algalstatic or algalcidal concentrations may lead to erroneous conclusions if the effects caused by lower, more realistic concentrations are ignored. An assessment that includes the effects caused by such concentrations will give more realistic information concerning the implications of trace contamination and the potential hazard of new chemicals. (Alexander-PTT)
W88-05117

**MEASUREMENT OF THE EFFECTS OF CADMIUM STRESS ON PROTOZOAN GRAZING OF BACTERIA (BACTERIVORY) IN ACTIVATED SLUDGE BY FLUORESCENCE MICROSCOPY,**
Louisville Univ., KY. Dept. of Biology.
For primary bibliographic entry see Field 5D.
W88-05193

**AMMONIA EFFECTS ON MICROINVERTEBRATES AND FISH IN OUTDOOR EXPERIMENTAL STREAMS,**
Environmental Research Lab.-Duluth, Monticello, MN. Monticello Ecological Research Station.
R. O. Hermanutz, S. F. Hedtke, J. W. Arthur, R. W. Andrew, and K. N. Allen.
Environmental Pollution EPEBD7, Vol. 47, No. 4, p 249-283, 1987. 4 fig, 6 tab, 43 ref.

Descriptors: *Water pollution effects, *Streams, *Ammonia, *Fish, *Invertebrates, *Toxicity, Growth rates, Water quality, Aquatic habitats, Habitats, Cladocerans, Copepods, Rotifers, Protozoa, Fathead minnows, Trout, Bluegills, Catfish, Sucker, Walleye.

Four outdoor experimental streams were used to evaluate the effects of ammonia on microinvertebrates and six fish species during a 76-week period. Three streams were dosed so that total ammonia concentrations averaged about 1, 3, and 9 mg/liter, with the control stream at 0.1 mg/liter. Copepod and rotifer populations did not appear to be adversely affected by any of the ammonia concentrations. Cladocerans were reduced in all three treatments relative to the control, but the reduction did not follow a concentration-response relationship. Protozoans had reduced numbers in the medium

and high treatments, but the differences were not statistically significant. Monitoring of cladocerans in the in situ biomonitor chambers showed complete mortality in the medium and high treatments. First generation survival, maturation rates, and growth rates for fathead minnows were similar in all four streams. Bluegill survival was not correlated with ammonia concentrations, but a significant reduction in growth and standing stock occurred in the high treatment stream. Channel catfish (1984-B group) had higher mortality in the high and medium treatment streams. The 1983 group of channel catfish, exposed the longest, showed significantly less growth by the end of the study in the medium and high treatment streams. White suckers of the 1983 group had highest mortality in the control stream, but no growth reduction was noticed. The 1984 group of white suckers showed growth reductions in all three treatments and substantially reduced standing stock in the high and medium treatments. For walleye, concentration-response trends were observed for growth and mortality. Results of rainbow trout mortality and growth were not consistent among the 1983-1984 group and the 1984-A and 1984-B groups. (Cassar-PTT)
W88-05198

**GROUNDWATER CONTAMINATION FROM SEPTIC SYSTEMS RECEIVING DETERGENTS OF TWO TYPES OF FORMULATION,**
Wisconsin Univ.-Madison. Dept. of Water Chemistry.
For primary bibliographic entry see Field 5B.
W88-05213

**REGIONAL WATER AVAILABILITY AND GLOBAL CLIMATIC CHANGE: THE HYDROLOGIC CONSEQUENCES OF INCREASES IN ATMOSPHERIC CARBON DIOXIDE AND OTHER TRACE GASES,**
California Univ., Berkeley. Energy and Resources Group.
P. H. Gleick.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8624768. Ph.D Dissertation, 1986. 615 p, 113 fig, 56 tab, 212 ref, 6 append.

Descriptors: *Air pollution effects, *Model studies, *Hydrologic balance, *Watersheds, *Climatology, *Runoff forecasting, *Soil water, Runoff, Basins, Runoff volume, Climatic data, Flooding, Irrigation water, Drought.

A modified water-balance model was developed to evaluate the effects of climatic changes on runoff and soil moisture in the Sacramento Basin watershed in California. The model was validated with long-term historical data and then driven with both hypothetical changes in precipitation and temperature and changes estimated by three general circulation models. The water-balance model was used to estimate the change in monthly, seasonal, and annual runoff and in available water capacity in the soil caused by changes in precipitation and temperature. Eighteen climate-change scenarios were evaluated. Results suggest dramatic shifts in the timing of runoff and the availability of soil moisture on a monthly and seasonal basis, decreases in summer soil-moisture values and runoff volumes, and increases in winter runoff volumes. The significant decreases in the availability of summer soil moisture in the Sacramento Basin will mean either increases in the overall demand for irrigation water during the summer months or in the moisture stress experienced by agricultural crops. The runoff results raise serious concerns about flooding and drought possibilities and severities. Significantly larger winter-runoff volumes will challenge the existing flood-control system. (Cremmins-AEPCO)
W88-05216

**PREDICTION OF NUISANCE BLUE-GREEN ALGAL GROWTH IN NORTH CAROLINA WATERS,**
North Carolina Univ. at Chapel Hill. Dept. of Biology.
V. H. Smith.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-132816/AS. Price codes: A03 in paper copy; A01 in microfiche. North Carolina Water Resources Research Institute, Raleigh, Completion Report No. 233, May 1987. 34 p, 9 fig, 3 tab, 50 ref.

Descriptors: *Predictive models, *Algal growth, *Algal biomass, *North Carolina, *Reservoirs, *Cyanophyta, Algae, Turbidity, Hydraulic flushing, Inorganic carbon, Chowan River, Neuse River.

In the State of North Carolina, nuisance blooms of blue-green algae have caused water quality problems in the Chowan and Neuse Rivers, and the potential for similar blue-green problems is still an unresolved question in new impoundments such as the B. E. Jordan and the Falls of the Neuse Reservoirs. Few general models have yet been developed for the prediction and the management of the blue-green algal blooms in freshwaters. However, Smith (1985) has recently developed a set of empirical models predicting the summer mean biomass of blue-green algae (mm3/m), and models predicting the relative biomass of blue-greens in the phytoplankton (Smith 1986). These models can potentially be used as tools to help manage North Carolina water resources experiencing nuisance blue-green algal growth. However, these empirical models were developed entirely from north temperate data, and their applicability to North Carolina reservoirs is not known. The objective of this research was to test the applicability of these models to North Carolina reservoirs. Statistical analysis of data from 34 reservoirs, collected and made available by the state of North Carolina Division of Environmental Management and by the Duke Power Company, suggested that none of the above models for blue-green algae were applicable to North Carolina reservoirs. The reasons for the lack of fit are not yet clear, but may include effects of non-algal turbidity, hydraulic flushing, and inorganic carbon availability. (Lambert-UNC, WRRI)
W88-05227

**EUTROPHICATION IN WATER SUPPLY RESERVOIRS: GENERAL IMPACTS ON POTABLE WATER PREPARATION,**
Cagliari Univ. (Italy). Ist. di Igiene e Medicina Preventiva.
A. Contu, N. Sechi, G. Sarritzu, A. Loizzo, and L. Volterra.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1191-1193, 1987. 1 fig.

Descriptors: *Eutrophication, *Reservoirs, *Water quality, *Potable water, Water treatment, Water storage, Algae, Lake Flumendosa, Lake Mulargia, Italy, Drinking water, Toxicity.

In January 1985 a massive algal bloom occurred in two Sardinian artificial lakes, Lakes Flumendosa and Mulargia, which are connected by a tunnel and which supply water for industry and irrigation in the Campidano plain and to the aqueduct of the city of Cagliari, Italy. Since the bloom, water samples were taken at various depths twice a month at a sampling station located on Lake Mulargia about 1 km from the dam to evaluate trends in concentrations of nitrogen and phosphorus compounds, pH, transparency, temperature, total chlorophyll and Oscillatoria rubescens density. The analytical tests confirmed that Lake Mulargia is highly eutrophic, and pointed out that the water treatment practices were inefficient in dealing with the O. rubescens bloom. With water treatment operations such as prechlorination, flocculation, filtration and final chlorination, parameters such as turbidity, organic substances, color, ammonia nitrogen, nitrite nitrogen, total coliforms and microbial flora were successfully contained within acceptable limits. However, from January to July, finished water appeared slightly lactescent due to the presence of mucilaginous secretions of O. rubescens and to small concentrations of the algae. It is recommended that long term effects of daily consumption of this water be determined since it was shown experimentally to be toxic to mice. (Wood-PTT)
W88-05250

**EEL (ANGUILLA ANGUILLA L.) AS A BIOINDICATOR OF METAL POLLUTION: FACTORS LIMITING ITS USE,**
Nantes Univ. (France). Centre de Dosage des Elements Traces.
For primary bibliographic entry see Field 5A.
W88-05258

**EUTROPHICATION OF LAKE SAVA,**
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
M. Perisic, P. Marjanovic, and V. Mitrovic.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1269-1273, 1987. 2 fig, 1 tab, 8 ref.

Descriptors: *Eutrophication, *Water quality, *Eutrophic lakes, *Lakes, Monitoring, *Lake Sava, Yugoslavia, Algal growth, Nutrients, Water quality control, Water quality management, Recreation, Nutrient removal, Cycling nutrients, Sediments.

A water quality monitoring program was initiated in 1983 for Lake Sava, a highly eutrophic lake in Yugoslavia. The Lake Sava system consists of a sedimentation basin and a recreation and infiltration lake which is filled by pumping water from the Sava River at a rate that depends on the evaporation rate and infiltration. As a result, the retention time of the water in the lake varies from 1.5 to 2 months during the summer and is slightly longer in the winter due to decreased evaporation and water use. Samples were collected monthly from three stations in the lake, one in the sedimentation basin, and one on the Sava River at the point of water withdrawal into Lake Sava. All samples were analyzed for selected physical, chemical and biological characteristics. The major external factors affecting the lake water quality were: (1) the water quality of the Sava River which had high concentrations of phosphorus, nitrogen and trace nutrients, (2) intense recreational use during the summer, and (3) air pollution caused by domestic and industrial burning of coal and firewood without adequate pollution control devices. However, internal processes of nutrient recycling also contributed to the accelerated eutrophication of the lake. Results showed that the net production of organic matter in the system on an annual basis results in accumulation of significant sediments which have high concentrations of organic matter, heavy metals, pesticides and nutrients. Suggestions for water quality management practices and remedial measures to control eutrophication of Lake Sava are presented including physico-chemical treatment of influent water for phosphorus and nitrogen reduction and removal of the sediment providing nutrients. (Wood-PTT)
W88-05269

**ECOTOXICOLOGICAL EFFECT INDICES: A RAPIDLY EVOLVING SYSTEM,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
For primary bibliographic entry see Field 5A.
W88-05292

**PRODUCTIVITY AS A POPULATION PERFORMANCE INDEX IN LIFE-CYCLE TOXICITY TESTS,**
Vrije Univ., Amsterdam (Netherlands). Biological Lab.
N. N. van Straalen, and R. G. M. de Goede.
Water Science and Technology WSTED4, Vol. 19, No. 11, p 13-20, 1987. 2 fig, 1 tab, 20 ref.

Descriptors: *Productivity, *Population dynamics, *Toxicity, *Life cycles, *Insects, *Forest soils, *Cadmium, Stress, Populations, Biomass, Ecology, Soil types, Heavy metals, Water pollution effects, Mortality, Predation, Distribution, Seasonal distribution.

Toxicity at the population level is often measured by the intrinsic rate of population increase (r sub m). The biomass turnover ratio (P/B) of a population is introduced as another measure of population performance under toxic stress. An expression was derived by which the intrinsic P/B ratio may be

calculated from life-table data. Unlike r sub m, P/B depends also on the individual growth curve. The theory is exemplified by experimental data on the effect of cadmium on Orchesella cincta (Collembola) from forest soil. The results are compared with seasonal fluctuations of productivity in an unstressed field population. Toxic effects of cadmium appear at a much lower exposure level than would be deduced from the P/B ratio. Some mechanism of compensation seems to be present in that the high natural mortality (by predation) obscures the sublethal effects on growth. This may explain why Collembola can inhabit forest soils that are contaminated to levels far above the no-effect level for individual growth. (Author's abstract)
W88-05293

**RESEARCH ON THE PHYSIOLOGICAL BASIS OF POPULATION DYNAMICS IN RELATION TO ECOTOXICOLOGY,**
Hoofdgroep Maatschappelijke Technologie TNO, Delft (Netherlands).
S. A. L. M. Kooijman, A. O. Hanstveit, and N. van der Hoeven.
Water Science and Technology WSTED4, Vol. 19, No. 11, p 21-37, 1987. 3 fig, 1 tab, 67 ref.

Descriptors: *Population dynamics, *Ecology, *Toxicity, *Physiology, *Ecosystems, *Reviews, Stress, Adaptation, Research priorities, Energy, Nutrients, Cycling nutrients, Water pollution effects, Algae, Bacteria, Model studies.

The aims and principles of fundamental research on ecotoxicology are reviewed. It is concluded that one of the main obstacles that hampers ecotoxicology is the poor insight into the relationship between physiological and population dynamics. The role of laboratory experiments, modeling, mathematical analysis, and computer simulation studies is discussed in research aimed at this relation. Energy and nutrient budgets of organisms of vital importance. Progress made in concrete efforts to work out energy and nutrient budgets for simple freshwater plankton systems stressed by toxic chemicals and different modes of action is evaluated. (Doria-PTT)
W88-05294

**VARIABILITY OF TEST SYSTEMS USED TO ASSESS ECOLOGICAL EFFECTS OF CHEMICALS,**
Construction Engineering Research Lab. (Army), Champaign, IL.
For primary bibliographic entry see Field 5A.
W88-05295

**SELECTION OF TEST SYSTEMS FOR ECOLOGICAL ANALYSIS,**
Illinois Univ., Urbana. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W88-05296

**WHOLE ECOSYSTEM MANIPULATION EXPERIMENTS: THE SEARCH FOR GENERALITY,**
Minnesota Univ., St. Paul. Dept. of Forest Resources.
J. A. Perry, N. H. Troelstrup, M. Newsom, and B. Shelley.
Water Science and Technology WSTED4, Vol. 19, No. 11, p 55-71, 1987. 5 fig, 1 tab, 58 ref. U. Minn. Coll. For. Ag. Exp. Sta. Project 42-025 and EPA Contracts CR 812468-01-1 and 810981-01.

Descriptors: *Reviews, *Ecology, *Stress, *Ecological effects, *Ecosystems, *Water pollution effects, Organic matter, Litter, Decomposition, Bacteria, Soil bacteria, Microbiological studies, Streams, Density, Population density, Microscopic analysis, Water analysis, Energy, Nutrients, Cycling nutrients.

Population- and community-level responses observed during two recent whole-ecosystem manipulations are summarized and examined in light of the literature. In one experiment, streams were dosed with chlorine and ammonia; in the other, a lake was acidified. It is concluded that the effects of any disturbance first occur as changes in the function (physiology) of individual organisms. Depending on the characteristics of the disturbance and of the system, effects may later be observed at higher levels of biological organization. The integrative nature of structure and function at the community and/or ecosystem level precludes the use of either class of variable alone for assessing responses to disturbance. Generalities in the ways that community and ecosystem structure and function respond to disturbance follow hypothesized trends, including reduced efficiency in system energetics, higher nutrient export and decreased nutrient standing stock, and reductions in diversity, evenness, and total numbers of organisms. These generalities provide a verified framework for evaluating other stresses and analyzing other types of stress. (Doria-PTT)
W88-05297

**INHIBITION OF METABOLIC HYDROGEN ION FLUX RESULTING FROM CADMIUM STRESS IN AQUATIC MICROECOSYSTEMS,**
MAXIMA Corp., Oak Ridge, TN.
W. D. Nicholas, and A. R. Abernathy.
Water Science and Technology WSTED4, Vol. 19, No. 11, p 85-94, 1987. 5 fig, 1 tab, 19 ref.

Descriptors: *Hydrogen ion concentration, *Toxicity, *Cadmium, *Ecological effects, *Water pollution effects, Aquatic environment, Fluctuations, Stress, Heavy metals, Environment, Computers, Photosynthesis, Respiration, Acidity.

The effects of light- and dark-induced pH changes were examined in naturally-occurring ecosystems under cadmium stress. Periodic changes in pH were monitored at 30 s intervals in a shallow eutrophic pond. The pH of the system was controlled between two setpoints with a microcomputer. When the upper setpoint was reached, a light bank was turned off until the pH dropped to the lower setpoint, and the light was again turned on. The cycling of the pH in the microcosms was analyzed using time series analysis techniques. Each experiment resulted in a 24-hour control data set and a 24-hour experimental data set that began with the addition of an inhibitor or toxicant. EC50 values for net photosynthesis and respiration of the community were calculated from slopes of the periodic response to cadmium and compared to literature values. The EC50 for dark-induced pH change was 3.8 ppm while the EC50 for light-induced pH change was 0.51 ppm. Increasing cadmium concentrations caused dominant peaks in the variance periodograms to be shifted to longer periods. (Doria-PTT)
W88-05299

**BIOASSAYS WITH AQUATIC ORGANISMS: TOXICITY OF WATER AND SEDIMENT FROM CUBATAO RIVER BASIN,**
Companhia de Tecnologia de Saneamento Ambiental, Sao Paulo (Brazil).
P. A. Zagatto, E. Gherardi-Goldstein, E. Bertoletti, C. C. Lombardi, and M. H. R. B. Martins.
Water Science and Technology WSTED4, Vol. 19, No. 11, p 95-106, 1987. 5 fig, 2 tab, 20 ref.

Descriptors: *Cubatao River, *Maji River, *Perdido River, *Bioassay, *Toxicity, *Water pollution effects, *Sediments, Assay, Bioindicators, Water analysis, Daphnia, Crustaceans, Algae, Chlorophyta, Chlorella, Basins, River basins, Catchment areas, Brazil, Fertilizers, Industrial wastewater.

Bioassays with Daphnia similis were performed with river water samples and sediment extracts from 18 sampling stations in the Cubatao region of Brazil. Water samples from rivers that receive discharges from fertilizer plants were assayed with Chlorella vulgaris. Results show no acute toxicity in samples and extracts collected upstream from the plants. Downstream, acute toxicity was detected in several samples. Perdido River water was most toxic to Daphnia. Moji River water downstream of the discharges had low pH values and was eutrophic, and showed acute toxicity to Daphnia and algae. Chemical and bioassays indicated that sediment from the Perdido River is highly polluted. Mercury concentrations in various other locations were high. It is concluded that environmental conditions in the Cubatao area are inadequate for maintenance of aquatic life. These data will serve as a reference as water quality improves under the Environmental Pollution Control Program. (Doria-PTT)
W88-05300

**USE OF THE BENTHIC COMMUNITY AS A WATER QUALITY INDICATOR IN THE CUBATAO RIVER BASIN,**
Companhia de Tecnologia de Saneamento Ambiental, Sao Paulo (Brazil).
G. Johnscher-Fornasaro, and P. A. Zagatto.
Water Science and Technology WSTED4, Vol. 19, No. 11, p 107-112, 1987. 1 fig, 1 tab, 12 ref.

Descriptors: *Piacaquiera River, *Maji River, *Pereque River, *Perdido River, *Bioindicators, *Cubatao River, *Benthos, *Water pollution effects, Bioassay, Assay, River basins, Catchment areas, Aquatic life, Rivers, Density, Population density, Water analysis, Sediments, Brazil.

A survey of the benthic macrofauna was performed along the rivers in the Cubatao region of Brazil to evaluate the aquatic environment. Twenty samples were collected in the Pereque, Cubatao, Moji, Piacaguera, and Perdido rivers during Spring and Autumn, 1984. Two numerical indices, the Sequential Comparison Index and Biotic Index, were calculated using sample data. Density in each sample was determined for each taxonomic group. The index calculations showed that the environment is not in equilibrium at any of the sampling stations. Heavy organic pollution in Cubatao and Piacaguera rivers was indicated. In the Perdido river, sediment was contaminated with tar. Pieces of insect larvae, also present in the sediment, indicated impacts from toxic substances. At other sampling stations, the low numerical index values were related to the sediment nature (sandy in some stations) or to non-organic pollution which was evaluated using bioassays. (Author's abstract)
W88-05301

**EFFECT OF CHLORINE DIOXIDE WATER DISINFECTION ON HEMATOLOGIC AND SERUM PARAMETERS OF RENAL DIALYSIS PATIENTS,**
California Dept. of Health Services, Berkeley.
R. G. Ames, and J. W. Stratton.
Archives of Environmental Health AEHLAU, Vol. 42, No. 5, p 280-285, September-October, 1987. 2 tab, 24 ref.

Descriptors: *Chlorine, *Disinfection, *Blood, *Hospitals, *Water pollution effects, Public health, Tissue analysis, Chlorination, Water treatment, Filtration, Reverse osmosis, Membrane processes, Carbon, Activated carbon.

A study of the blood chemistry parameters of 20 renal dialysis patients was undertaken when a local water district introduced chlorine dioxide (ClO2) as a disinfectant at the filtration plant headworks for 12 months without informing the renal dialysis clinic. Due to data limitations, the analysis was focused on 17 patients for whom data was produced by the same clinical laboratory for three months of pre-exposure and one month of exposure. Least-square means of each parameter by ClO2 levels of 0.0 and 1.0 mg/l at the treatment plant were adjusted for age, sex, and creatinine. Water purification at the clinic included passing the water through granular activated carbon, filtration by 5-micron filters, and reverse osmosis. Chlorination products measured at the clinic after this purification and prior to preparation of the dialysate consisted only of chlorite at the 0.02-0.08 mg/l level. No evidence of ClO2-induced anemia was found, nor were any other biologically significant responses observed. Study limitations include several potentially important hematologic parameters which were not measured, the small sample size, and three clinical laboratory changes. (Author's abstract)

W88-05303

**VARIABILITY IN THE FREQUENCY OF SISTER-CHROMATID EXCHANGE IN LARVAE OF MYTILUS EDULIS: IMPLICATIONS FOR FIELD MONITORING,**
Lawrence Livermore National Lab., CA. Environmental Sciences Div.
I. M. Jones, and F. L. Harrison.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 113, No. 3, p 283-288, December 15, 1987. 1 fig, 15 ref. DOE Contract No. W-7405-ENG-48.

Descriptors: *Water pollution effects, *Bioindicators, *Toxicity, *Mytilus, *Monitoring, *Marine environment, Indicators, Mussels, Mollusks, Water quality management.

Striking variation in the frequency of sister-chromatid exchange (SCE) was detected in progeny of different groups of field-collected and control Mytilus edulis adults from Tomales Bay, CA. Ability to detect SCE was accomplished by exposure of developing larvae to 5-bromodeoxyuridine. The results demonstrate that there is no intrinsic limit to the frequency of occurrence of SCE in mussel larvae. The results imply that the mussel larval SCE assay may have greater sensitivity than indicated by previous studies of SCE induction by direct exposures of larvae to SCE-inducing chemicals. In addition, although the cause of the high SCE frequencies is unknown, the observations indicate that direct analysis of transgenerational transfer of genotoxic agents should be performed. It is concluded that, with further study, this assay may be useful in detecting environmental exposures to genotoxic contaminants. (Author's abstract)
W88-05305

**COMPARISON OF FISH COMMUNITIES IN A CLEAN-WATER STREAM AND AN ADJACENT POLLUTED STREAM,**
Ohio State Univ., Columbus. Environmental Biology Program.
R. J. Reash, and T. M. Berra.
American Midland Naturalist AMNAAF, Vol 118, No. 2, p 301-322, October 1987. 6 fig, 6 tab, 38 ref. U.S.Army Corps of Engineers Contract DACW69-83-M-0698.

Descriptors: *Water pollution effects, *Stream pollution, *Fish populations, *Aquatic habitats, Habitats, Species diversity, Stream fisheries, Fisheries, Ecosystems, Wastewater pollution, Ammonia, Insects, Heavy metals, Metals, Invertebrates, Benthic invertebrates, Mohican River, Ohio.

Fish populations were studied in two parallel tributaries of the Mohican River, Ohio: Clear Fork, relatively undisturbed; and Rocky Fork, which receives industrial discharges and sewage effluent. Water quality in Rocky Fork was significantly worse than the control stream with respect to heavy metals (Cr, Cu, Fe, Ni, and Zn) and ammonia concentrations. Fish species richness and diversity increased downstream in Clear Fork but decreased downstream in Rocky Fork. Pollution-intolerant species (lampreys, darters, sculpins) were present in the headwaters of Rocky Fork and at all sites of Clear Fork. Fish community similarity at midriver sites was significantly greater in Rocky Fork than in Clear Fork. Likewise, similarity of fish communities between corresponding headwater sites was significantly greater than similarity of corresponding downstream reaches, using polluted and unpolluted sites for comparison. Total species richness of fish feeding on generalized invertebrates, benthic insects, and insects-fishes decreased downstream at polluted sites but remained stable in Clear Fork sites. Both headwater sites were dominated numerically by generalized invertebrate-feeding fish. At downstream sites in Clear Fork benthic insectivores became dominant (37-68% of all fishes per season); in Rocky Fork, generalized invertebrate-feeding fish (54-94% of all fishes per season) were present. Fish communities at polluted sites had comparatively lower variability of both trophic structure rank and relative abundance. The smaller populations of fish in these sites were dominated by a few pollution-tolerant species. (Cassar-PTT)
W88-05362

**EFFECTS OF ACID-IRON WASTES ON ESTUARINE ORGANISMS: RECENT FIELD AND LABORATORY EXPERIMENTS,**
Laboratoire Municipal d'Hygiene, Le Havre (France).
F. Proniewski, and P. Lassus.
Marine Biology MBIOAJ, Vol. 96, No. 3, p 451-457, November 1987. 7 fig, 3 tab, 30 ref.

Descriptors: *Water pollution effects, *Estuaries, *Acidic water, *Iron, *Aquatic habitats, Habitats, Marine biology, Seine Estuary, France, Titanium dioxide wastes, Wastewater pollution, Industrial wastes, Zooplankton, Phytoplankton, Fish, Shrimp, Eels, Hydrogen ion concentration, Bioassay.

The effects of acid-iron waste from a titanium dioxide plant on marine fauna were studied in the Seine Estuary, France, during 1982 and 1983. The waste, composed of diluted sulfuric acid, ferrous sulfate and some trace heavy metals, is dumped daily at a volume of 15,600 cu m and a pH of 0.8-1.2. Field tests showed the following results: (1) pH of the estuarine water quickly reached 2-3 after dumping and returned to about 8 after 4 min. (2) Fish (sticklebacks and eels) and brown shrimp showed no increased mortality after crossing the effluent plume. Laboratory bioassays failed to reveal any deleterious effects on phytoplankton or zooplankton of exposure to pH 3 for 30 or 90 sec. (Cassar-PTT)
W88-05381

**CHEMICAL CONTAMINANTS MONITORING: PESTICIDE RESIDUES IN LAKE ALBUFERA, VALENCIA, SPAIN,**
Universidad Politecnica de Valencia (Spain). Dept. of Biotechnology.
For primary bibliographic entry see Field 5B.
W88-05393

**EFFECTS OF ACIDIC DEPOSITION ON THE CHEMISTRY OF HEADWATER STREAMS: A COMPARISON BETWEEN HUBBARD BROOK, NEW HAMPSHIRE, AND JAMIESON CREEK, BRITISH COLUMBIA,**
Syracuse Univ., NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W88-05433

**ADAPTATION OF AQUATIC MICROBIAL COMMUNITIES TO HG(++) STRESS,**
Environmental Protection Agency, Gulf Breeze, FL. Gulf Breeze Lab.
T. Barkay.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 12, p 2725-2732, December 1987. 2 fig, 4 tab, 41 ref.

Descriptors: *Water pollution effects, *Estuaries, *Salt marshes, *Adaptation, *Microorganisms, *Mercury, *Genetics, Saline water, Coastal marshes, Marshes, Ponds, Seepage water, Bayous, Rivers, Aquatic habitats, Habitats, Thompson's Bayou, Escambia River, Florida, Inhibition, Metals, Heavy metals.

The mechanism of adaptation to Hg(++) in four aquatic habitats was studied by correlating microbially mediated Hg(++) volatilization with the adaptive state of the exposed microbial communities. The sampling sites were in the vicinity of Pensacola, Florida, and included an estuary (Santa Rosa Sound), a salt marsh (Range Point Pond), fresh water in Thompson's Bayou, and coastal waters of the Gulf of Mexico. Community diversity, heterotrophic activity, and Hg(++) resistance measurements indicated that adaptation of all four communities were stimulated by preexposure to HG(++). In the saline water communities, adaptation was associated with rapid volatilization after an initial lag period. In the freshwater communities Hg(++) was volatilized slowly, regardless of the resistance level of the microbial community. If the mer operon were coded for Hg(++) resistance and volatilization, its distribution in preexposed communities would be increased. However, the distribution was not related to Hg(++) adaptation. (Cassar-PTT)
W88-05447

**TESTING FOR BACTERIAL RESISTANCE TO ARSENIC IN MONITORING WELL WATER BY THE DIRECT VIABLE COUNTING METHOD,**
Maryland Univ., College Park. Dept. of Microbiology.
For primary bibliographic entry see Field 5A.
W88-05453

**TRENDS OF ORGANOCHLORINE RESIDUES IN EGGS OF BIRDS FROM ITALY, 1977 TO 1985,**
Pavia Univ. (Italy). Dipt. Biologia Animale.
For primary bibliographic entry see Field 5B.
W88-05455

**EFFECT OF MALATHION AND GAMMA-BHC ON THE LIPID METABOLISM IN RELATION TO REPRODUCTION IN THE TROPICAL TELEOST, CLARIAS BATRACHUS,**
Banaras Hindu Univ., Varanasi (India). Fish Endocrinology Lab.
B. Lal, and T. P. Singh.
Environmental Pollution EPEBD7, Vol. 48, No. 1, p 37-47, 1987. 4 fig, 1 tab, 19 ref. New Delhi grants DST (HCS/DST/928/80) and ICAR (PL-480 project No. IN-ARS-213 and Grant No. FG-IN-620).

Descriptors: *Water pollution effects, *Pesticides, *Malathion, *Lipids, *Fish, *Reproduction, *Organochlorine pesticides, *Organophosphorus pesticides, *Hexachlorocyclohexane, Clarias batrachus, Insecticides, Cholesterol, Hormones, Sublethal effects, Toxicity.

Female Clarias batrachus were exposed to two sublethal concentrations of gamma-BHC (1,2,3,4,5,6 - hexachlorocyclohexane; 2 and 8 micrograms/liter) and malathion (1 and 4 micrograms/liter) for 4 weeks during different phases of their reproductive cycle. Impact of these pesticides on free fatty acids, monoglycerides, diglycerides, triglycerides, phospholipids, free and esterified cholesterol in the liver, plasma, ovary, and muscle was assessed. During the pre-vitellogenic and regressed phases, they suppressed the levels of fatty acids and glycerides in the liver but had no effect on their levels in the plasma, ovary and muscle. However, in the vitellogenic phase, fatty acids in the liver and plasma were increased, but were decreased in the ovary and muscle. Glycerides were also decreased in the studied tissues. In the post-vitellogenic phase these pesticides increased the levels of fatty acids and glycerides in the liver and ovary, but decreased their levels in the plasma. Both pesticides decreased hepatic phospholipids in the pre-vitellogenic phase, while in the vitellogenic phase only gamma-BHC reduced its levels in the liver. These pesticides also restricted their mobilization to the ovary. Cholesterol biosynthesis seemed unaffected, but the hydrolysis of esterified cholesterol to free cholesterol was adversely affected during the period of estrogen biosynthesis. (Author's abstract)
W88-05456

**EFFECT OF WATER PH AND SALINITY ON THE SURVIVAL OF EGGS AND LARVAE OF THE EURYHALINE TELEOST, GASTEROSTEUS ACULEATUS L.,**
University Coll. of Wales, Aberystwyth. Dept. of Zoology.
A. A. Faris, and R. J. Wootton.
Environmental Pollution EPEBD7, Vol. 48, No. 1, p 49-59, 1987. 4 fig, 2 tab, 22 ref.

Descriptors: *Acid rain, *Water pollution effects, *Eggs, *Salinity, *Larvae, *Stickleback, *Hydrogen ion concentration, *Fish, *Acidic water, Gasterosteus aculeatus, Toxicity, Spawning.

The effect of water acidification and salinity on the survival of eggs and larvae of the euryhaline teleost, Gasterosteus aculeatus (three-spined stickleback) was studied using tap water low in calcium (1.55 mg/liter) and high in total aluminum (0.23 mg/liter). The survival of eggs from fertilization to hatching increased with an increase in pH from 4.5 to 6.5. Survival was higher at a given pH at higher salinities (equivalent to 5% and 10% sea water) than in tap water. The salinity experienced by the female prior to spawning also affected egg survival. Survival for 7 days after hatching was high except at the lowest pH levels. The salinity experienced by the female had no significant effect on larval survival. (Cassar-PTT)
W88-05457

**EFFECTS OF A CARBAMATE INSECTICIDE, CARBARYL, ON THE SUMMER PHYTO- AND ZOOPLANKTON COMMUNITIES IN PONDS,**
National Inst. for Environmental Studies, Tsukuba (Japan). Environmental Biology Div.
T. Hanazato, and M. Yasuno.
Environmental Pollution EPEBD7, Vol. 48, No. 2, p 145-159, 1987. 7 fig, 1 tab, 44 ref.

Descriptors: *Water pollution effects, *Ponds, *Pesticides, *Insecticides, *Carbamates, *Carbaryl, *Zooplankton, *Phytoplankton, *Ecological effects, Cladocerans, Algae, Rotifers, Aquatic habitats, Habitats, Ecosystems, Plankton.

A carbamate insecticide, carbaryl (1-methyl-N-methylcarbamate), was applied in concrete ponds to study the effects of plankton communities. In the control pond Cladocera declined after an increase in density of inedible algae, and rotifers became dominant as Chaoborus larvae suppressed the Cladocera increase. Addition of 1 ppm of carbaryl to a similar pond killed all zooplankton and Chaoborus larvae. The absence of Chaoborus larvae allowed the Cladocera to increase rapidly and contributed to suppression of the rotifer population. A second carbaryl application 12 days later produced the same phenomenon. The phytoplankton community was not directly affected by the chemical application, but changes in the zooplankton community structure did causes alterations in the phytoplankton community. (Cassar-PTT)
W88-05458

**ACID RAIN AND POLLEN GERMINATION IN CORN,**
Massachusetts Univ., Amherst. Dept. of Plant and Soil Sciences.
F. S. Wertheim, and L. E. Craker.
Environmental Pollution EPEBD7, Vol. 48, No. 3, p 165-172, 1987. 5 tab, 14 ref. USDA Grant 84-CRSR-202391.

Descriptors: *Water pollution effects, *Acid rain, *Corn, *Germination, *Pollen, *Reproduction, *Hydrogen ion concentration, Seeds, Crop yield, Rainfall, Phosphates, Sulfates, Simulated rainfall.

Simulated acid rain was applied to the silks of corn, Zea mays L., to assess its effects on pollen germination. Reduced germination appeared directly related to the acidity of the rain. Pollen germination (expressed as percentage of no rain control) was 94.0% for pH 5.6; 81.0% for pH 4.6; 72.0% for pH 3.6; and 62.3% for pH 2.6. The time between rain treatment and pollination (10 or 60 min) had no effect on pollen germination on silks exposed to pH 2.6 water. Simulated rain applied 5 min after pollination, however, totally inhibited pollen germination regardless of pH because the pollen grains were washed away before the tubes could penetrate the silk surface. The duration of rain application (<1.5 min or 1 hour) did not increase the effect on pollen germination. The nature of the acidifying component (sulfate vs. phosphate) was not significant. Using pH 5.6 water to rinse silks that had been treated with 2.6 water did not improve pollen germination, suggesting that reduced germination was caused by physical and/or chemical modifications to the silk surface and not to residual acid on the tissue. (Cassar-PTT)
W88-05459

**CHRONIC EFFECTS OF CD ON REPRODUCTION OF POLYPEDILUM NUBIFER (CHIRONOMIDAE) THROUGH WATER AND FOOD,**
National Inst. for Environmental Studies, Tsukuba (Japan). Environmental Biology Div.
S. Hatakeyama.
Environmental Pollution EPEBD7, Vol. 48, No. 4, p 249-261, 1987. 3 fig, 4 tab, 22 ref.

Descriptors: *Water pollution effects, *Cadmium, *Midges, *Aquatic insects, *Reproduction, *Heavy metals, Eggs, Insects, Invertebrates, Larvae, Metals, Aquatic habitats, Habitats, Toxicity.

Chronic effects of cadmium on reproduction of Polypedilum nubifer (Chironomidae) were investigated by Cd-exposure from the egg stage using a flow-through aquarium. No significant effect of Cd on reproduction was observed in the midge larvae which had been exposed to 10 or 20 micrograms Cd per liter. Emergence of the Cd-exposed larvae peaked several days before that of the control, although growth was impaired in first and/or second instars. The percentage emergence success decreased to about 46% of the control at 40 micrograms Cd/liter. However, other reproductive processes (adult sex ratio, oviposition success and egg hatchability) were not impaired. The emergence success decreased to less than 3% of the control at 80 micrograms Cd/liter. The emergence success of midge larvae which had been fed Cd-contaminated food with 220 or 1800 micrograms Cd/gram decreased to nearly 60% of the control. However, other reproductive processes were not impaired. Emergence success of larvae exposed to food containing 22 micrograms Cd/gram was unaffected. (Author's abstract)
W88-05460

**TOXIC EFFECTS OF MERCURIC CHLORIDE ON SPERM AND EGG VIABILITY OF TWO POPULATIONS OF MUMMICHOG, FUNDULUS HETEROCLITUS,**
Rutgers - The State Univ., Newark, NJ. Dept. of Biological Sciences.
A. T. Khan, and J. S. Weis.
Environmental Pollution EPEBD7, Vol. 48, No. 4, p 263-273, 1987. 3 fig, 36 ref.

Descriptors: *Water pollution effects, *Mercury, *Reproduction, *Mummichog, *Fish, *Eggs, *Sperm, *Heavy metals, Metals, Fertilization, Toxicity.

Two mummichog populations were used to study the effects of mercury on fertilization. Fish were obtained from the relatively clean water near Bullhead Bay, Long Island, New York (LI mummichog) and from Piles Creek, New Jersey, a polluted tidal creek (PC mummichog). Exposure of sperm from LI mummichog to 0.01 ppm mercuric chloride for 2 min had no significant effect on fertilization success. Similar exposure of sperm from PC mummichog reduced fertilization success. Increased exposure (up to 0.05 ppm Hg and 5 min) greatly reduced the fertilization success of both populations. Eggs which were fertilized during these experiments developed normally. Exposure of sperm to 0.05 ppm Hg for 2 min significantly reduced the motility of sperm from the PC population but had no effect on sperm from the LI population. Exposure of both PC and LI sperm either to 15 ppt sea water or to 0.05 ppm Hg for 15 min did not affect the morphology of the sperm. Eggs proved to be more tolerant to Hg effects. Exposure of PC and LI mummichog eggs to 0.05 ppm Hg for up to 25 min had no effect on fertilization success. (Cassar-PTT)
W88-05461

**MORTALITY RESPONSE AND LC50 VALUES FOR JUVENILE AND ADULT CRAYFISH, PROCAMBARUS CLARKII EXPOSED TO THIODAN (INSECTICIDE), TREFLAN, MSMA, OUST (HERBICIDES) AND CUTRINE-PLUS (ALGICIDE),**
Southern Univ., Baton Rouge, LA. Dept. of Biological Sciences.
S. M. Naqvi, R. Hawkins, and N. H. Naqvi.
Environmental Pollution EPEBD7, Vol. 48, No. 4, p 275-283, 1987. 2 tab, 20 ref. National Institutes of Health grants 8125 and 8135.

Descriptors: *Water pollution effects, *Pesticides, *Crayfish, *Toxicity, *Lethal limit, Herbicides, Insecticides, Algicides, Mortality, Juvenile growth stage, Thiodan, Endosulfan, Treflan, Trifluralin, Monosodium methanearsonate, Oust, Cutrine-Plus, Invertebrates.

Toxicities of pesticides to juvenile (3.0-3.4 cm) and adult (9.0-10.0 cm) freshwater crayfish were determined by 96-hour static bioassays, using aged tap water to prepare pesticide solutions. For juvenile crayfish the LC50 values were as follows: Thiodan, 24 ppb; Treflan, 13 ppm; monosodium methane arsenate (MSMA), 101 ppm; Cutrine-Plus, 461 ppm; Oust, 12,174 ppm. For adults the LC50s were as follows: Thiodan, 423 ppb; Treflan, 26 ppm; MSMA, 1019 ppm; Cutrine-Plus, 2945 ppm; and Oust, no mortalities up to the highest concentration tested, 60,000 ppm. (Cassar-PTT)
W88-05462

**EFFECTS OF SIMULATED ACID RAIN ON THE GROWTH OF THREE HERBACEOUS SPECIES GROWN ON A RANGE OF BRITISH SOILS,**
Institute of Terrestrial Ecology, Bangor (Wales). Bangor Research Station.
T. W. Ashenden, and S. A. Bell.
Environmental Pollution EPEBD7, Vol. 48, No. 4, p 295-310, 1987. 3 fig, 4 tab, 26 ref.

Descriptors: *Water pollution effects, *Acid rain, *Barley, *Ryegrass, *Clover, Hydrogen ion concentration, Plant growth, Vegetation, Soil chemistry, Crop yield, Simulated rainfall.

Seedlings of winter barley, perennial ryegrass, and white clover were exposed to simulated acid rainfall (pHs 5.6, 4.5, 3.5, and 2.5) for 21-24 weeks on several British soils, ranging from sensitive to non-sensitive with respect to acid leaching. The pH 2.5 treatment produced lesions on leaves of white clover, but there were no signs of visible injury to the other two species. At harvest all species showed great variation in sizes of individual plants. This made it difficult to detect differences between treatments for plants on an individual soil. The yields of winter barley and clover were highly correlated with rainfall pH; lower yields were obtained with the lower pH water. In contrast, ryegrass plants produced higher yields of shoots at the most acid (pH 2.5) treatment. Soils were generally more acid after the pH 2.5 treatment. (Cassar-PTT)
W88-05463

**BACTERIAL BIOABSORPTION OF NICKEL FROM INDUSTRIAL COOLING WATER,**
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W88-05464

**GROWTH AND PHYSIOLOGICAL RESPONSES OF YELLOW-POPLAR SEEDLINGS EXPOSED TO OZONE AND SIMULATED ACIDIC RAIN,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Plant Pathology and Physiology.
A. H. Chappelka, B. I. Chevone, and J. R. Seiler.
Environmental Pollution EPEBD7, Vol. 49, No. 1, p 1-18, 1988. 5 fig, 3 tab, 32 ref.

Descriptors: *Water pollution effects, *Acid rain, *Trees, *Seedlings, *Growth, Plant growth, Yellow poplar, Stomatal transpiration, Leaves, Root development, Rainfall, Biomass.

Nine-week-old yellow-poplar (Liriodendron tulipfera L.) seedlings were exposed to ozone for 4 hours/day, 5 days/week in combination with simulated acid rain (pH 3.0, 4.3 or 5.6 for 1 hour/day, 2 days/week at 0.75 cm/hour) for 6 weeks under controlled laboratory conditions. The main effect caused by simulated acid rain was a linear decrease in stomatal conductance with increasing acidity.

For combined pollutant effects, ozone applied at 0.05 or 0.10 microliters/liter resulted in significant linear decreases in dry weights and relative growth rates of stems and leaves and in cumulative leaf area as the solution pH decreased. Root-to-shoot ratio decreased linearly, whereas stem relative growth rate and cumulative leaf area increased linearly in response to decreasing pH for seedlings exposed to 0.15 microliters/liter ozone. Seedlings treated with a pH 5.6 solution exhibited a linear decrease in leaf dry weight and relative growth rate and a linear increase in root-to-shoot ratio as ozone concentrations increased. (Cassar-PTT)
W88-05465

**EFFECT OF COPPER SULFATE ON SOME BIOCHEMICAL PARAMETERS OF RAINBOW TROUT,**
Bristol Univ. (England). Research Unit for Comparative Animal Respiration.
J. G. Nemcsok, and G. M. Hughes.
Environmental Pollution EPEBD7, Vol. 49, No. 1, p 77-85, 1988. 2 fig, 2 tab, 28 ref.

Descriptors: *Water pollution effects, *Fish, *Copper sulfate, *Trout, *Heavy metals, Metals, Rainbow trout, Toxicity.

The effects of 0.2 and 2.0 ppm copper sulfate on rainbow trout were studied by sampling blood from chronically implanted cannulae and directly by cardiac or caudal puncture. The duration of copper exposure was 24 hours, and blood samples were taken before exposure and at 24 and 48 hours after the treatment. Measurement of aspartate aminotransferase and alanine aminotransferase activities and blood glucose levels showed a 2-4 fold increase in these parameters. Conversely, acetylcholinesterase activity decreased by 40% after 24 hours. These results indicate the presence of tissue necrosis and a general stress effect. (Cassar-PTT)
W88-05468

**EFFECT OF ACIDIFIED WATER ON THE TRACHEARY ELEMENTS OF THE FIRST MAIZE (ZEA MAYS L.) INTERNODE AND CONDITIONS DETERMINING ELONGATION OF THIS INTERNODE,**
Agricultural Univ., Wageningen (Netherlands). Vakgroep Plantencytologie en Morfologie.
R. W. Den Outer, and M. G. Boersma.
Acta Botanica Neerlandica AHBPAX, Vol. 36, No. 3-4, p 283-293, November 1987. 9 fig. 3 tab, 12 ref.

Descriptors: *Water pollution effects, *Acid rain, *Corn, Plant tissues.

Conditions for the formation of a long first internode (mesocotyl shoot) of maize (Zea mays L.) formed in a relatively short period of time were analyzed. In an inert substrate the growth of such a shoot was mainly determined by the uptake of water. Using a simulated acid rain (pH 3.0, 4.0, 4.5) observations were made on the morphology and anatomy of first internodes and roots of young seedlings produced by deeply sown maize grains in an inert substrate. Seedlings cultivated with acidic water showed more tracheary elements in the mesocotyl. The effect was more distinct when a combination of sulfuric and nitric acids was applied than when acids were applied individually. Radial endodermis cell walls in the mesocotyl were up to twice as thick in plants treated with acidic water than in control plants treated with tap water. (Cassar-PTT)
W88-05488

**SHIGELLOSIS OUTBREAK ASSOCIATED WITH SWIMMING,**
Oklahoma State Dept. of Health, Oklahoma City. Epidemiology Service and Lab. Service.
S. Makintubee, J. Mallonee, and G. R. Istre.
American Journal of Public Health AJHEAA, Vol. 77, No. 2, p 166-168, February 1987. 1 fig, 2 tab, 20 ref.

Descriptors: *Water pollution effects, *Shigellosis, *Swimming, *Human disease, *Epidemiology, Diseases, Public health, Reservoirs.

In June 1982 an outbreak of gastrointestinal illness caused by Shigella sonnei occurred among residents of two counties in Oklahoma. A case-control study of cases and age and sex-matched controls showed an association with attendance at a southern Oklahoma lake (14/17 cases vs. 3/17 controls, matched pair odds ratio (OR) 9/0, confidence interval (CI) 2.4-infinity). A survey of 85 persons who had visited the lake area showed that persons who had swum were more likely to have been ill with a gastrointestinal illness (50%) than persons who had not swum (0%); among those who had swum, illness was more frequent among those who reported having water in their mouths while swimming (62%) than those who did not (19%) (OR = 6.9, 95% CI = 2.2-21.5). No further primary lake-associated cases had onset of symptoms beyond two days of closing the reservoir. Swimming should be considered as a potential source of enteric infections. (Author's abstract)
W88-05489

**PROSPECTIVE STUDY OF GIARDIASIS AND WATER SUPPLIES IN COLORADO,**
Lovelace Medical Foundation, Albuquerque, NM. Clinical Research Div.
S. C. Lapham, R. S. Hopkins, M. C. White, J. R. Blair, and R. A. Bissell.
American Journal of Public Health AJHEAA, Vol. 77, No. 3, p 354-355, March 1987. 12 ref.

Descriptors: *Water pollution effects, *Epidemiology, *Giardiasis, *Human diseases, Parasites, Colorado, Drinking water, Water supply, Risks, Diseases.

A prospective study of 484 visitors to Vail and Aspen/Snowmass, Colorado, was conducted to determine the risk of acquiring giardiasis. Of the 259 visitors to Vail, no cases of giardiasis were confirmed, and only one of 12 water filtrates was positive for Giardia cysts. Of 225 visitors to Aspen/Snowmass, two cases of giardiasis were confirmed and 12 of 20 water filtrates were positive for Giardia cysts. The regular occurrence of Giardia cysts in Aspen and Snowmass water was associated with lower rates of giardiasis acquisition than reported during outbreaks of waterborne giardiasis. (Author's abstract)
W88-05490

**FOLLOW-UP STUDY OF GASTRO-INTESTINAL DISEASES RELATED TO BACTERIOLOGICALLY SUBSTANDARD DRINKING WATER,**
Centre Alpin de Recherche Epidemiologique et de Prevention Sanitaire, Grenoble (France).
D. Zmirou, J. P. Ferley, J. F. Collin, M. Charrel, and J. Berlin.
American Journal of Public Health AJHEAA, Vol. 77, No. 5, p 582-584, May 1987. 3 tab, 16 ref.

Descriptors: *Water pollution effects, *Human diseases, *Groundwater pollution, *Epidemiology, *Bacteria, Public health, Drinking water, Water pollution, Risks, Standards, Water quality standards, Impaired water quality, Coliforms, Streptococcus.

In a prospective followup study conducted in 52 French alpine villages, one weekly water sample was taken in each village provided with untreated groundwater and analyzed as to the presence of four indicator bacteria: total plate count, total coliforms, thermotolerant (fecal) coliforms, and fecal streptococci. Cases of acute gastrointestinal disease occurring among 29,272 inhabitants were reported through physicians, pharmacists, and primary school teachers. A loglinear model identified fecal streptococcus as the best predictor; the presence of fecal coliforms enhanced the effect of fecal streptococcus. The total bacteria count and the total coliforms had no independent contributions. A threshold analysis suggested that any level of indicator bacteria above zero was associated with an excess of acute gastrointestinal disease. (Author's abstract)
W88-05491

**EPIDEMIC GIARDIASIS CAUSED BY A CONTAMINATED PUBLIC WATER SUPPLY,**
Centers for Disease Control, Atlanta, GA. Div. of Field Services.
G. P. Kent, J. R. Greenspan, J. L. Herndon, L. M. Mofenson, and J. S. Harris.
American Journal of Public Health AJHEAA, Vol. 78, No. 2, p 139-143, February 1988. 2 fig, 2 tab, 15 ref.

Descriptors: *Water pollution effects, *Epidemiology, *Human diseases, *Giardiasis, Impaired water quality, Public health, Water supply, Reservoirs, Drinking water, Water treatment.

In the period November 1, 1985 to January 31, 1986, 703 cases of giardiasis were reported in Pittsfield, Massachusetts (population 50,265). The community obtained its water from two main reservoirs (A and B) and an auxiliary reservoir (C). Potable water was chlorinated but not filtered. The incidence of illness peaked approximately two weeks after the city began obtaining a major portion of its water from reservoir C, which had not been used for three years. The attack rate of giardiasis for residents of areas supplied by reservoir C was 14.3/1000, compared with 7.0/1000 in areas that received no water from reservoir C. A case-control study showed that persons with giardiasis were more likely to be older and to have drunk more municipal water than household controls. A community telephone survey indicated that over 3,800 people could have had diarrhea that might have been caused by Giardia, and 95% of households were either using alternate sources of drinking water or boiling municipal water. Environmental studies identified Giardia cysts in the water of reservoir C. Cysts were also detected in the two other reservoirs supplying the city, but at lower concentrations. This investigation highlights the risk of giardiasis associated with unfiltered surface water system. (Author's abstract)
W88-05492

**DEVELOPMENTAL TOXICITY OF HALOGENATED ACETONITRILES: DRINKING WATER BY-PRODUCTS OF CHLORINE DISINFECTION,**
Health Effects Research Lab., Cincinnati, OH.
M. K. Smith, E. L. George, H. Zenick, J. M. Manson, and J. A. Stober.
Toxicology TXCYAC, Vol. 46, No. 1, p 83-93, October 1987. 1 fig, 3 tab, 15 ref.

Descriptors: *Water pollution effects, *Chlorine, *Halogenated byproducts, *Growth rates, *Rats, *Drinking water, Halogens, Toxicity, Acetonitriles, Fertility, Byproducts, Reproduction, Mortality.

The developmental toxicity of acetonitrile and 5 halogenated derivatives was examined with an in vivo teratology screen adapted for use in the Long-Evans rat. The screen was extended to an evaluation of growth until postnatal days 41-42, and weight of several organs at sacrifice. Acetonitrile was without developmental effects even at doses toxic to the dam. Of the halogenated compounds, treatment with trichloroacetonitrile (TCAN) and dichloroacetonitrile (DCAN) resulted in reduced fertility and increased implantation failure. There was no effect on litter size in females bearing live litters, but pup birth weight was reduced in all litters exposed to halogenated compounds. Perinatal survival of the pups was adversely impacted by DCAN and TCAN. Postnatal growth until day 4 was reduced by DCAN and bromochloroacetonitrile (BCAN) while growth until day 42 was consistently affected only by TCAN. Some general observations were made on the usefulness of the criteria used in the screen, and TCAN, the most toxic of the halogenated, was selected for further in-depth evaluation. (Author's abstract)
W88-05497

**TOXICOLOGICAL STUDIES OF CHEMICAL MIXTURES OF ENVIRONMENTAL CONCERN AT THE NATIONAL TOXICOLOGY PROGRAM: HEALTH EFFECTS OF GROUNDWATER CONTAMINATION,**
National Toxicology Program, Research Triangle

Park, NC.
R. S. H. Yang, and E. J. Rauckman.
Toxicology TXCYAC, Vol. 47, No. 1/2, p 15-34, December 1987. 4 tab, 54 ref.

Descriptors: *Water pollution effects, *Toxicity, *Chemical mixtures, *Groundwater pollution, *Experimental design, *Planning, Hazardous materials, Waste dumps, Groundwater, Rats, Inorganic compounds, Organic compounds, National Toxicology Program.

In cooperation with the Agency for Toxic Substances and Disease Registry, the National Toxicology Program is participating in a Public Health Service activity related to the Comprehensive Environmental Response, Compensation and Liability Act (Superfund Act) by conducting toxicology studies on chemicals found in high-priority hazardous waste sites and for which adequate toxicological data are not available. As part of this effort, a project on the toxicology of chemical mixtures of groundwater contaminants was initiated. The first study centered on the health effects of groundwater contaminants, is at the contractual stage. Nineteen organic and six inorganic chemicals, selected from more than 1000 known groundwater contaminants, will be given in drinking water to Fischer 344 rats and B6C3F sub 1 mice for 3 or 6 months. Controls and five dose levels, based on average concentrations (i.e., baseline level) of individual component chemicals, or 0.1-, 10-, 100-, or 1000-fold of the baseline level, will be used. Toxicological end points include mortality, clinical signs, water and food consumption, body and organ weights, clinical pathology analytes (eg., hematology, clinical chemistry and urinalysis), gross and histopathology, neurobehavioral tests, sperm morphology and vaginal cytology evaluations (SMVCE), and cytogenetics. The rationale behind the complex experimental design and the factors to consider when designing studies of complex chemical mixtures are summarized. (Author's abstract)
W88-05498

**COMMUNITY WATER-CONTACT PATTERNS AND THE TRANSMISSION OF SCHISTOSOMA HAEMATOBIUM IN THE HIGHVELD REGION OF ZIMBABWE.**
Blair Research Lab., Harare (Zimbabwe).
Social Sciences and Medicine SSMDEP, Vol. 25, No. 5, p 495-505, September 1987. 3 fig, 9 tab, 30 ref.

Descriptors: *Water pollution effects, *Infection, *Schistosomiasis, *Snails, *Water contact patterns, *Zimbabwe, Diseases, Pathology, Human diseases, Human pathology, Distribution patterns. Seasonal variation.

The patterns of community water-contact, their relationships to Schistosoma haematobium infection in the human population and also in Bulinus globosus, snail host for S. haematobium and S. mattheei were carried out at 12 human water contact sites located in stream habitats in the temperate highveld region of Zimbabwe over a 27-month period during 1982-1984. It was shown that water contact was markedly heterogeneous with sex, age, type of activity and village location being the major variables affecting water-contact patterns. This heterogeneity in contact appears to be related to variations in levels of infection with S. haematobium among residents of the villages and by sex but in adults high water-contact was not associated with increased levels of infection and this discrepancy is attributed to the influence of acquired immunity in adults. An association was found between total body exposure indices and prevalence of S. haematobium in B. globosus in the cool dry and hot dry period of the year indicating that the level of input of schistosome eggs into the water plays an important role in determining snail infection rates, although the absence of clearcut relationships between the two parameters in the rainy and post-rainy periods suggest that other factors may be involved. (Author's abstract)
W88-05499

**EFFECTS OF ACID RAIN ON FRESHWATER ECOSYSTEMS,**
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
D. W. Schindler.
Science SCIEAS, Vol. 239, No. 4836, p 149-157, January 8, 1988. 1 fig, 108 ref.

Descriptors: *Water pollution effects, *Acid rain, *Freshwater ecosystems, *Aquatic ecosystems, *Literature review, Water pollution, Ecosystems, Reviews, North America, Rainfall, Neutralization, Hydrogen ion concentration, Invertebrates, Acidic water, Lakes.

Acid-vulnerable areas are more numerous and widespread than believed 7 years ago. Lakes and streams in acid-vulnerable areas of northeastern North America have suffered substantial declines in acid-neutralizing capability, the worst cases resulting in biological damage. Many invertebrates are very sensitive to acidification, with some disappearing at pH values as high as 6.0. However, the recent rate of acidification of lakes is slower than once predicted, in part the result of decreases in sulfur oxide emissions. A discussion of some of the processes that have contributed to the acidification of lakes as well as those that have protected acid-sensitive freshwaters is presented. (Author's abstract)
W88-05506

**ANTILUNG CANCER ACTIVITIES OF SELENIUM,**
Pittsburgh Univ., PA. Graduate School of Public Health.
For primary bibliographic entry see Field 5F.
W88-05544

**COMPARATIVE METABOLISM OF NITROAROMATIC COMPOUNDS IN FRESHWATER, BRACKISH WATER AND MARINE DECAPOD CRUSTACEANS,**
California Univ., Davis. Dept. of Environmental Toxicology.
For primary bibliographic entry see Field 5B.
W88-05560

**ACUTE AND SUBCHRONIC TOXICITY IN RATS OF TRANS-1,2-DICHLORO-ETHYLENE IN DRINKING WATER,**
Medical Coll. of Virginia, Richmond. Dept. of Pharmacology and Toxicology.
J. R. Hayes, L. W. Condie, J. L. Egle, and J. F. Borzelleca.
Journal of the American College of Toxicology, JACTDZ, Vol. 6, No. 4, p 471-478, February 1988, 4 tab, 14 ref.

Descriptors: *Dichloroethylene, *Toxicity, *Drinking water, *Water pollution, Chlorinated hydrocarbons, *Rodents, Organic compounds, Respiration, Public health.

Trans-1,2-dichloroethylene was administered by gavage (acute studies) or in drinking water (subchronic studies) to male and female Sprague-Dawley derived Charles River rats. The acute oral LD50 was 7902 mg/kg for males and 9939 mg/kg for females. Decreased activity, ataxia, and depressed respiration preceded death. In the subchronic study, rats received theoretical daily doses of 500, 2500, and 3000 mg/kg body weight/day for 90 consecutive days. The actual daily doses were 402, 1314, and 3114 mg/kg for males and 353, 12,257, and 2809 mg/kg for females. There were no compound-related deaths. There were no consistently significant compound-related dose-dependent adverse effects on any of the hematological, serological, or urinary parameters evaluated. There were dose-dependent increases in kidney weights and ratios in females. There were no compound-related gross or histological effects. No specific organ site toxicity could be identified. The toxicity from exposure to trans-1,2-dichloroethylene in drinking water apparently is low and probably does not constitute a serious health hazard. (Author's abstract)
W88-05562

**EFFECTS OF BLEACHED KRAFT MILL EFFLUENT ON EARLY LIFE STAGES OF BROWN TROUT (SALMO TRUTTA L.),**
Finnish Game and Fisheries Research Inst., Helsinki. Fisheries Div.
M. Vuorinen, and P. J. Vuorinen.
Ecotoxicology and Environmental Safety EESADV, Vol. 14, No. 2, p 117-128. 6 fig, 1 tab, 47 ref.

Descriptors: *Water pollution effects, *Trout, *Effluents, *Toxicity, *Kraft mills, *Pulp wastes, Bleached kraft mill effluent, Eggs, Life cycles.

Brown trout (Salmo trutta L.) eggs fertilized in clean water were incubated in bleached kraft mill effluent (BKME) concentrations of 0, 0.5, 1, and 2% (v/v) in a continuous-flow system and exposure was continued with the sac fry for most of the yolk sac stage. In addition, sac fry first incubated in clean water were exposed after hatching to the same concentrations for 44 days. Percentage hatching was lower than in the control only in 2% BKME. In all the BKME concentrations, the newly hatched sac fry were shorter than the controls, and their heart rate was slower. All the sac fry in 2% BKME died within 3 weeks after the end of hatching. At the late yolk sac stage the sac fry in the other concentrations of BKME were shorter and less well developed than the controls. Their wet and dry weights were higher and their water content was lower because of retarded yolk absorption. Exposure commencing after hatching also caused retarded growth and development. In the sac fry exposed to BKME only after hatching, mortality increased with the concentration and all the sac fry in 2% BKME died within 4 weeks. (Author's abstract)
W88-05571

**RESPONSES OF TROUT FRY (SALMO GAIRDNERI) AND XENOPUS LAEVIS TADPOLES TO CADMIUM AND ZINC,**
Southampton Univ. (England). Dept. of Biology.
C. Woodall, N. Maclean, and F. Crossley.
Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 89C, No. 1, p 93-99, January 1988. 8 tab, 23 ref.

Descriptors: *Trout, *Frogs, *Cadmium, *Zinc, *Toxicity, Biosynthesis, Metallothionein synthesis, Metabolism, Heavy metals.

Toxicity of cadmium chloride and zinc sulfate in solution has been determined for Xenopus tadpoles and rainbow trout fry in recirculated water systems. Both animals show approximately equal tolerance of zinc but Xenopus tadpoles tolerate cadmium at approximately 10 times the lethal concentration for trout fry. In the case of Xenopus tadpoles, pre-treatment with sub-lethal concentrations of cadmium or zinc protects against subsequent exposure to either metal. For trout fry, cadmium gives little protection against later exposure to either cadmium or zinc, while zinc gives moderate protection against either metal. Protection is attributed to metallothionein synthesis. (Author's abstract)
W88-05575

**TOXIC EFFECT OF COPPER ON DAPHNIA MAGNA (CRUSTACEA, CLADOCERA) WITH VARYING FOOD CONCENTRATIONS,**
Moscow State Univ. (USSR).
Y. L. Gerasimov.
Doklady Biological Sciences DKBSAS, vol. 293, No. 1-6, p 174-176, September 1987. 2 fig, 2 tab, 5 ref. Translated from Doklady Akademii Nauk SSSR, Vol. 293, No. 6, p 1510-1513, April 1987.

Descriptors: *Water pollution, *Daphnia, *Copper, *Toxicity, *Chlorella, Postembryonic development, Food density, Heavy metals.

The goal of this work was to estimate the toxic action of copper ions on the survival, growth, and reproduction of Daphnia magna straus at varying food concentrations. Newborn Daphnia specimens of a single size were placed in an open glass beaker filled with 300 ml of media, 15 specimens per

beaker. The media was prepared with tap water (left standing for 3-4 days) to which the toxicant, CuCl2, was added. Food, the alga Chlorella vulgaris, was also added. Copper concentrations (from Cu(+ +) ions) were 0.01, 0.05, 0.06, and 0.1 mg per liter. Chlorella densities of 50,000 (low density), 150,000 (medium density), and 400,000 (high density) cells per ml were used. The results of the experiment showed that, in the control variants (no copper), and in Cu concentrations of 0.01 and 0.05 mg per l, survival of Daphnia was best under conditions of greater food density, and was considerably worse under medium and low densities. In those variants where toxicant concentrations were 0.06 and 0.1 mg per l, improved food conditions had almost no influence on daphnia survival. Copper slowed postembryonic development at concentrations of 0.06 mg per l and higher. (Roseman-PTT)
W88-05576

**LONG-TERM EFFECTS OF TREATED DOMESTIC WASTEWATER ON BROWN TROUT,**
Pennsylvania Cooperative Fish and Wildlife Research Unit, University Park.
R. F. Carline, A. J. Benson, and H. Rothenbacher.
Water Research WATRAG, Vol. 21, No. 11, p 1409-1415, November 1987. 2 fig, 4 tab, 20 ref.

Descriptors: *Wastewater, *Water pollution effects, *Trout, *Treated wastewater, *Municipal wastewater, *Ammonia, Domestic wastes, Wastewater, Water pollution, Fish, Growth, Fish behavior, Gills, Toxicity, Sublethal effects, Effluents, Spring Creek, Pennsylvania.

A 12-month bioassay was conducted to determine the effects of unchlorinated, treated, domestic wastewater from the Spring Creek Pollution Control Facility in Pennsylvania on survival, growth, swimming performance, and gill tissue of brown trout (Salmo trutta) in Spring Creek. Ammonia was the toxicant of concern because the facility's effluent contained concentrations of ammonia that seasonally exceeded the U.S. Environmental Protection Agency (EPA) recommendations in the late winter and spring months. Juvenile brown trout (initial weight of 2), which were exposed to six concentrations (0-37%) of effluent, were fed a restricted ration, so that growth rates were similar to those of wild, stream residents. At the highest effluent concentration, monthly mean concentrations of un-ionized ammonia ranged from 0.004 to 0.055 mg/l NH3-N (atomic weight = 14); these concentrations exceeded the EPA criterion of 0.016 mg/l about 40% of the time. There were no significant effects of effluent concentration on survival, growth, or swimming performance of brown trout, but the degree of damage to gills was directly related to effluent concentration. (Wood-PTT)
W88-05600

**SPATIAL AND TEMPORAL VARIATION IN HYPOLIMNETIC OXYGEN DEFICITS OF A MULTIDEPRESSION LAKE,**
Baylor Univ., Waco, TX. Dept. of Biology.
O. T. Lind.
Limnology and Oceanography LIOCAH, Vol. 32, No. 3, p 740-744, May 1987. 1 fig, 3 tab, 17 ref.

Descriptors: *Limnology, *Hypolimnion, *Oxygen deficit, *Eutrophication, *Douglas Lake, Spatial distribution, Temporal distribution, Distribution, Land use, Temperature, Water temperature, Oxygen, Dissolved oxygen, Lakes, Eutrophic lakes.

Marked differences in areal hypolimnetic oxygen deficits were found among three depressions of Douglas Lake, Michigan. These differences were similar to those measured 11 yr before, and indicate that regional patterns of nutrient input, production, and eutrophication exist. The patterns are related to lakeshore land use and development. The rate of eutrophication has accelerated across the lake over the 11-yr span. This increase in eutrophication rate would not have been detected had not the hypolimnetic oxygen deficit data also taken into account the differences in hypolimnetic temperatures between the two studies. In fact, without considering temperature, it would have been concludeed, that the rate of eutrophication was lessening. (Author's abstract)
W88-05609

**DISPOSITION OF TOXIC PCB CONGENERS IN SNAPPING TURTLE EGGS: EXPRESSED AS TOXIC EQUIVALENTS OF TCDD,**
State Univ. of New York at Albany. Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W88-05618

**POLYCHLORINATED BIPHENYLS IN BLUE CRABS FROM SOUTH CAROLINA,**
South Carolina State Dept. of Health and Environmental Control, Columbia.
For primary bibliographic entry see Field 5B.
W88-05620

**PCB CONCENTRATIONS IN WINTER FLOUNDER FROM LONG ISLAND SOUND, 1984-1986,**
National Marine Fisheries Service, Milford, CT. Milford Lab.
For primary bibliographic entry see Field 5B.
W88-05621

**TOXICITY OF METHYLENE CHLORIDE TO LIFE STAGES OF THE FATHEAD MINNOW, PIMEPHALES PROMELAS RAFINESQUE,**
Dow Chemical Co., Midland, MI. Dept. Health and Environmental Sciences.
For primary bibliographic entry see Field 5A.
W88-05622

**POLYCHLORINATED DIBENZO-P-DIOXINS IN BLUE MUSSEL FROM MARINE COASTAL WATER IN JAPAN,**
Setsunan Univ., Neyagawa (Japan).
For primary bibliographic entry see Field 5B.
W88-05623

**ACUTE TOXICITY OF CADMIUM TO EIGHT SPECIES OF MARINE AMPHIPOD AND ISOPOD CRUSTACEANS FROM SOUTHERN CALIFORNIA,**
Korea Ocean Research and Development Inst., Seoul (Republic of Korea).
For primary bibliographic entry see Field 5B.
W88-05624

**AS, CD, CU, PB, HG, AND ZN IN FISH FROM THE ALEXANDRIA REGION, EGYPT,**
Institute of Oceanography and Fisheries, Alexandria (Egypt).
A. El Nabawi, B. Heinzow, and H. Kruse.
Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 39, No. 5, p 889-897, November, 1987. 1 fig, 3 tab, 16 ref.

Descriptors: *Arsenic, *Cadmium, *Copper, *Mercury, *Zinc, *Fish, *Egypt, *Tissue analysis, Tilapia, Muscle, Liver, Heavy metals, Photometry, Atomic absorption spectrophotometry, Public health.

Metal concentrations were determined in samples of several fish species collected from Abu Qir Bay, Idku Lake, and Maryut Lake. Total residues are usually slightly higher in organs than in muscle tissue. Interspecies variation was observed in the concentration of essential and toxic chemicals, but only mercury in two species, Pagellus erythrinus and Sphyraena sphyraena, could exceed the recommended limits for human intake if more than 3 kg are consumed per week. It is concluded that consumption of fish from the Alexandria region does not pose a health hazard. (Doria-PTT)
W88-05625

**ACUTE TOXICITY OF ZINC TO JUVENILE AND SUBADULT RAINBOW TROUT, SALMO GAIRDNERI,**
Scarborough Coll., Westhill (Ontario). Life Sciences Div.
For primary bibliographic entry see Field 5B.
W88-05626

**FIELD STUDY OF THE TOXICITY OF TWO OILS AND A DISPERSANT TO THE MANGROVE AVICENNIA MARINA,**
Adelaide Univ. (Australia). Centre of Environmental Studies.
J. A. Wardrop, A. J. Butler, and J. E. Johnson.
Marine Biology MBIOAJ, Vol. 96, No. 1, p 151-156, October, 1987. 4 fig, 3 tab, 24 ref.

Descriptors: *Phytotoxicity, *Oil spills, *Water pollution effects, *Field tests, *Organic compounds, *Mangrove swamps, *Coastal waters, Crude oil, Oil, Swamps, Toxicity, Shores, Coasts, Leaves, Plant physiology.

The relative toxicities of Arabian Light crude oil, Tirrawarra crude oil, Dispersant BP-AB, and mixtures of oils and dispersant were assessed on 30 mangroves, Avicennia marina var. resinifera, in a coastal fringe on the eastern shore of Gulf St. Vincent, South Australia. Five treatments were applied: 100% Arabian Light crude oil, 100% Tirrawarra crude oil, Arabian Light crude oil plus dispersant (1:1), Tirrawarra crude oil plus dispersant (1:1), and 100% dispersant. Five mangroves were used for each of the treatments and five as controls. Defoliation, leaf damage, pneumatophore damage, flowering, and fruiting were monitored for three years. Initially, the toxicity of both oils was increased by the addition of dispersant; Tirrawarra crude oil plus dispersant caused significant defoliation. 100% Tirrawarra crude oil was more toxic than 100% Arabian Light crude oil; the former caused significant leaf damage from Week 4 to Week 12 after treatment. After Week 49, production of new leaves was significantly greater in the Arabian Light crude oil plus dispersant treatment than with the Arabian Light crude oil. No such difference was found between the Tirrawarra treatments. Twelve to 26 weeks after treatment, partial pneumatophore damage was observed in all treatments. No atypical flower or fruit production was observed. (Author's abstract)
W88-05646

**IMPACT OF ACID MINE DRAINAGE ON THE STREAM ECOSYSTEM: PART I,**
California State Coll., PA. Dept. of Biological and Environmental Sciences.
W. G. Kimmel.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 21, No. 1, p 18-21, January-February, 1988. 2 tab, 1 ref.

Descriptors: *Acid mine drainage, *Aquatic environment, *Water pollution effects, *Streams, *Acidity, Mine drainage, Environment, Sulfur, Sulfuric acid, Coal mining, Chemical reactions, Iron, Chemical properties.

Acid mine drainage has destroyed countless aquatic ecosystems in coal-mining areas in Pennsylvania. The factors governing the sensitivity of stream ecosystems to acidification are discussed; the principal factors are size of drainage area and buffering capacity. The formation of acid mine drainage is also discussed; the complex reactions involved are chemical and biochemical in nature, and are increased by the activities of Thiobacillus and Ferrobacillus spp. Criteria for recognizing acid mine drainage are presented based on pH, Fe, SO4, suspended and dissolved solids, hardness, and related parameters. Cessation of active mining does not always halt the production of acid mine drainage, and it is concluded that America's energy problems are likely to accelerate environmental degradation if proper controls are not enforced. (Doria-PTT)
W88-05648

**DRINKING WATER MICROBIOLOGY.**
For primary bibliographic entry see Field 5F.
W88-05707

**PARADISE STEAM ELECTRIC PLANT, ASH-POND TOXICITY BIOMONITORING STUDY - OCTOBER 1986,**
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
For primary bibliographic entry see Field 5G.
W88-05710

**MUSSELWATCHING IN THE BUFFALO RIVER, TIMES BEACH AND LAKE ERIE,**
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5A.
W88-05720

**WES-TNO CONTAMINANT MOBILITY RESEARCH,**
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5B.
W88-05721

**PRELIMINARY INVENTORY OF PLANKTONIC AND BENTHIC ORGANISMS AT TIMES BEACH,**
Army Engineer Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 5E.
W88-05723

**PROCEEDINGS OF THE 1986 INTERNATIONAL SYMPOSIUM ON BIOFOULED AQUIFERS: PREVENTION AND RESTORATION.**
American Water Resources Association, Bethesda, MD.
American Water Resources Association, Bethesda, Maryland. 1987. 183 p. EPA Contract No. CR812759-01-0. Edited by D. Roy Cullimore.

Descriptors: *Aquifer characteristics, *Biofilms, *Clogging, *Biofouled aquifers, *Water pollution effects, *Groundwater quality, Corrosin, Fouling, Water quality, Aquifers, Biological studies, Biodegradation, Organic compounds, Plankton, Slime, Oxidation, Inorganic compounds.

Biofouled aquifers have only recently been recognized as a natural phenomenon of considerable potential importance. The obvious connotation is that the effects of this biological activity are deleterious to the functioning of the aquifer. This is indeed supported by both the reduced flow resulting from copious biofilm (slime) and freely suspended (planktonic) microorganisms present in the system. Favorable features of biofouling include the ability of the intrinsic flora to undertake the biodegradation of organic pollutants and (via oxidation/reduction or direct uptake) remove various specific inorganic components (eg., iron, manganese) from the aqueous. The International Symposium on Biofouled Aquifers: Prevention and Restoration was organized by the American Water Resources Association and held in November 1986. It represented a serious effort to come to terms with the various factors interacting both positively and negatively within a biofouled aquifer and potential to control them. The proceedings of this symposium represents an attempt to interject the microbiological and biochemical aspects into the more hydrological aspects of biofouling in aquifers. While the primary applied interest has been focused around corrosion and biodegradation, the symposium was designed to center around the primary source of these activities - the biofilm and its functioning. (See W88-05724 thru W88-05746) (Lantz-PTT)
W88-05724

**ECOLOGY OF IRON AND MANGANESE BACTERIA IN UNDERGROUND WATER,**
Institute for Technology of Nuclear and Other Mineral Raw Materials, Belgrade (Yugoslavia).
For primary bibliographic entry see Field 2F.
W88-05727

**PHYSICO-CHEMICAL FACTORS IN INFLUENCING THE BIOFOULING OF GROUNDWATER,**
Regina Water Research Inst. (Saskatchewan).
For primary bibliographic entry see Field 2F.
W88-05728

**CLOGGING OF DISCHARGE WELLS IN THE NETHERLANDS II: CAUSES AND PREVENTION,**
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
For primary bibliographic entry see Field 2F.
W88-05730

**BIOFILMS IN POROUS MEDIA,**
Montana State Univ., Bozeman. Inst. for Biological and Chemical Process Analysis.
For primary bibliographic entry see Field 2F.
W88-05731

**OXIDATION PROCESSES OF IRON IN GROUND WATER - CAUSES AND MEASURES,**
Stockholm Univ. (Sweden). Dept. of Geology.
R. O. Hallberg, and C. Nalser.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 143-155, 5 fig, 2 tab, 6 ref.

Descriptors: *Oxidation, *Iron, *Groundwater quality, *Clogging, *Water pollution effects, *Water quality control, Well screens, Bacterial growth, Oxalic acid, Hydrogen ion concentration, Water treatment, Wells.

The most common kinds of well-clogging, those caused by iron and manganese deposits are discussed. The mechanism for the precipitation of iron involving the species Gallionella is not understood. Therefore, thermodynamic calculations do not agree with field observations of bacterial activities. Sheath-forming iron bacteria, e.g., of the species Leptothrix, do not oxidize iron but merely act as precipitating sites for iron deposits and do not directly relate to the thermodynamic calculations. A method using oxalic acid is introduced for quick short-term rehabilitation of groundwater wells. This treatment follows this stepwise procedure: (1) Record initial specific capacity; (2) Record pH in the well and, if available, in additional wells in its vicinity; (3) Oxalic acid with a concentration of 1-2% is added to the well. The amount of water added will determine the treatment ozone outside the screen. Usually, a treatment zone of 0.5 m is sufficient; (4) A reaction time of 12-24 hours is recommended. pH of the well should be monitored at intervals throughout the reaction time. If pH exceeds 3, more acid should be added; (5) The well shall be pumped until the initial pH is obtained within a few tenths; and (6) Determine final specific capacity. If required, the treatment should be repeated. The only way to prevent a well from biofouling is to relocate the bacterially active zone from the well-screen to a place where precipitation of iron can take place without affecting the capacity of the well. (See also W88-05724) (Lantz-PTT)
W88-05739

**PERSISTENCE OF BIOLOGICALLY ACTIVE COMPOUNDS IN AQUATIC SYSTEMS,**
Wyoming Univ., Laramie.
A. M. Boelter, J. D. Fernandez, J. S. Meyer, D. A. Sanchez, and H. L. Bergman.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-007752. Price codes: A04 in paper copy, A01 in microfiche. Report No. DOE/ER/60071--1, November 1986. Final Report. 45 p, 1 fig, 12 tab, 22 ref, append. DOE Contract No. DE-AC02-82ER60071.

Descriptors: *Water quality, *Retort water, *Oil wastes, *Aquatic environment, *Path of pollutants, *Bioassays, Fate of pollutants, Biomonitoring, Macroinvertebrates, Minnows, Leachates, Water pollution effects, Lysimeters, Toxicity, Colorado, Oil shale.

Waters collected from two study sites were tested for persistence of biologically active compounds as the waters percolated through experimental media. At the first site, the Paraho Lysimeter in Anvil Points, Colorado, two leachate samples (early and late flow in Spring 1983) were collected from each of four piles of processed oil shale overlain by different thicknesses of soil. Although water quality differed among samples, six of eight lysimeter leachates tested were acutely toxic to an aquatic invertebrate, Daphnia magna, and five were acutely toxic to fathead minnows (Pimephales promelas). MgSO4 and Na2SO4 dominated the chemical composition of leachates and apparently contributed most of the observed toxicity. Water collected from a modified in situ (MIS) retort at the second site, Tract C-a near Meeker, Colorado, was percolated through columns containing three different types of soil. Raw leachate from the MIS spent shale (hereafter referred to as the retort water) was acutely toxic to an aquatic invertebrate, Ceriodaphnia dubia. The toxicity of samples from nine pore volumes of retort water percolating through a column containing a sandy soil increased with successive pore volumes, but leachate toxicity never equaled the toxicity of the retort water. In contrast, the first pore volumes of retort water or reconstituted water leached through a sandy loam soil collected on Tract C-a were more toxic than the retort water; however, the second pore volumes of leachates were not toxic. First pore volume leachates of retort water percolating through a sandy clay loam soil were much less toxic than the retort water; second pore volume leachates were not toxic. (Author's abstract)
W88-05747

**ASSESSMENT OF GREAT LAKES TILLAGE PRACTICES AND THEIR POTENTIAL IMPACT ON WATER QUALITY,**
Ohio State Univ., Columbus.
T. J. Logan.
IN: Effects of Conservation Tillage on Groundwater Quality: Nitrates and Pesticides. Lewis Publishers, Chelsea, Michigan. 1987. p 271-276, 9 ref.

Descriptors: *Nonpoint sources, *Great Lakes, *Water quality control, *Water pollution prevention, *Agricultural practices, *Water pollution sources, Tillage, Leaching, Path of pollutants, Groundwater pollution, Nitrogen, Nitrates, Fertilizers, Environmental effects.

Water quality problems associated with agricultural production are of particular concern in the Great Lakes Basin because of the intensive use of lands in this area for grain crops, the high net precipitation over evapotranspiration which results in significant runoff and leaching, and the proximity of these lands to one of the world's largest bodies of freshwater. Conservation tillage is being promoted in the Basin for control of nonpoint sources of phosphorus to the Great Lakes and the data indicate that Basin farmers are adopting this practice at a steady rate although most are shifting to a system minimizing tillage rather than to strictly no-till. Corn, soybeans, and winter wheat are the major crops of the region and, of these, only corn receives nitrogen fertilizer at rates which could contribute significantly to losses of nitrate in runoff and tile drainage or movement to groundwater. This potential for nitrate contamination of surface and groundwater with corn fertilization is a consequence of less-than-precise nitrogen fertilizer recommendations and less-than-efficient timing of fertilizer applications, regardless of the tillage system used. The accelerated adoption of conservation tillage is, therefore, unlikely to have much of an impact on these losses except to the extent that changes in hydrology with tillage may change the relative losses of nitrate to surface versus groundwater. The increased infiltration, and potential for increased groundwater contamination, observed with no-till on well-drained soils is less likely to occur on the more poorly-drained till soils of the Great Lakes Basin where runoff and tile drainage are greater than movement to groundwater. Weed and pest pressures on the major grain crops of the Basin are relatively low compared to conditions in the southern U.S. (See also W88-05759) (Lantz-PTT)
W88-05775

**EFFECTS OF BLACK ROCK HARBOR DREDGED MATERIAL ON THE HISTOPATHOLOGY OF THE BLUE MUSSEL MYTILUS EDULIS AND POLYCHAETE WORM NEPHTYS INCISA AFTER LABORATORY AND FIELD EXPOSURES,**
Environmental Research Lab., Narragansett, RI.
P. P. Yevich, C. Yevich, and G. Pesch.
Available from the National Technical Information Service, Springfield, VA. 22161 as ADA-188152. Price codes: A08 in paper copy; A01 in microfiche. Technical Report No. D-87-8, September 1987. Final Report. 156 p, 43 fig, 22 tab, 25 ref.

Descriptors: *Water pollution effects, *Black Rock Harbor, *Histopathology, *Mussels, *Worms, *Dredging, Field tests, Tissue analysis, Dredged material, Waste disposal, Gills, Bioaccumulation, Biological studies, Connecticut.

A study was conducted to field verify histopathological changes in two aquatic species, Mytilus edulis and Nephtys incisa, by comparing histological changes under both laboratory and field exposures to contaminated dredged material. A second objective of the study was to determine the degree of correlation between tissue residues resulting from bioaccumulation of dredged material contaminants with histopathological changes. A laboratory dosing system was designed to deliver a constant exposure concentration of suspended Black Rock Harbor (BRH) sediment to the blue mussel Mytilus edulis and the polychaete worm Nephtys incisa. Residue concentrations in both mussels and worms, particularly stable compounds such as polychlorinated biphenyls (PCBs), were closely related to exposure concentrations. Histopathological changes were seen in the female reproductive tract, gills, and gastrointestinal tract for M. edulis and the parapodial epidermis for N. incisa. Field exposure estimates of BRH suspended sediments at 1 m above the sediment-water interface indicated that maximum concentrations occurred during the disposal operation, after which exposure concentrations and tissue concentrations of BRH contaminants decreased to background within 1 to 2 months. The general lack of exposure to BRH sediments in the field resulted in no observed histopathological changes in M. edulis; consequently, no residue-effects relationships could be determined. The laboratory-field comparison for M. edulis is based upon a comparison of exposure conditions estimated from tissue residues and chemical data. Cluster analysis of the M. edulis residue data indicates that field residues are most similar to laboratory exposures to reference material. Field residues during disposal, though elevated, are less than those reported for the lowest laboratory exposure (1.5 mg/L) to BRH sediment. Laboratory results for N. incisa show significant increases in tissue residue values. The only histopathological observation was a darkening and thickening of the epidermal tissue of the parapodia. (Lantz-PTT)
W88-05847

**EMERSION IN THE MANGROVE FOREST FISH RIVULUS MARMORATUS: A UNIQUE RESPONSE TO HYDROGEN SULFIDE,**
Charleston Coll., SC.
For primary bibliographic entry see Field 2L.
W88-05856

**EFFECTS OF BLACK ROCK HARBOR DREDGED MATERIAL ON THE SCOPE FOR GROWTH OF THE BLUE MUSSEL, MYTILUS EDULIS, AFTER LABORATORY AND FIELD EXPOSURES,**
Environmental Research Lab., Narragansett, RI.
W. G. Nelson, D. K. Phelps, W. B. Galloway, P. F. Rogerson, and R. J. Pruell.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report D-87-7, September 1987. Final Report. 118 p, 30 fig, 17 tab, 33 ref.

Descriptors: *Black Rock Harbor, *Mussels, *Water pollution effects, *Dredging, Field tests, Tissue analysis, Bioaccumulation, Biological studies, Growth, Connecticut, Polychlorinated biphenyls, Waste disposal.

A study was conducted to investigate residue-effect relationships between tissue residue concentrations and the scope for growth of the blue mussel, Mytilus edulis, after exposure in the laboratory and the field to dredged material from Black Rock Harbor (BRH), Bridgeport, Connecticut. A second objective included field verification of the laboratory results. A laboratory system was used to provide a constant exposure concentration ranging from 0 to 10 mg/L of suspended BRH sediment. Residue concentrations in mussels, particularly stable compounds such as polychlorinated biphenyls, were found to be closely related to exposure concentration. Scope for growth, clearance rates, and shell growth measurements were inversely related to BRH exposure and subsequent tissue residues, with concentrations as low as 1.5 mg/L of BRH material causing negative biological effects. In the field, mussels were placed along a transect from the center of the disposal mound to a clean area distant from the disposal mound. Exposure estimates indicated that the maximum concentration BRH material occurred during the disposal operation, after which both exposure and tissue residue concentrations decreased dramatically. Of the measurements made at the four field stations during the course of the study, a reduction in the scope for growth of mussels, attributable to BRH material, was observed only once. The estimated concentration of BRH suspended material (0.7 to 0.2 mg/L) during that collection, 8 weeks postdisposal, was very close to the lowest concentration affecting the scope for growth in the laboratory experiments (1.5 mg/L). (Author's abstract)
W88-05860

**EMPIRICAL METHODS FOR PREDICTING EUTROPHICATION IN IMPOUNDMENTS. REPORT 4: PHASE III, APPLICATIONS MANUAL,**
For primary bibliographic entry see Field 7C.
W88-05861

**ALTERNATIVES FOR IDENTIFYING STATISTICALLY SIGNIFICANT DIFFERENCES,**
For primary bibliographic entry see Field 7C.
W88-05886

**EMPIRICAL POWER COMPARISONS OF SOME TESTS FOR TREND,**
Waterloo Univ. (Ontario). Dept. of Systems Design Engineering.
For primary bibliographic entry see Field 7C.
W88-05888

**PESTICIDE ASSESSMENT GUIDELINES, SUBDIVISION E, HAZARD EVALUATION: WILDLIFE AND AQUATIC ORGANISMS,**
Environmental Protection Agency, Washington, DC. Office of Pesticide Programs.
For primary bibliographic entry see Field 5A.
W88-05906

**CORPS' ENVIRONMENTAL EFFECTS OF DREDGING PROGRAMS,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
R. M. Engler, T. R. Patin, and R. F. Theriot.
Available from the National Technical Information Service, Springfield, VA. 22161. Miscellaneous Paper D-88-2, February 1988. Final Report. 13 p.

Descriptors: *Spoil disposal, *Dredging, *Environmental effects, Research needs, Project planning, Information exchange, Waste disposal.

Prior to the 1970s, little research was conducted by the Corps of Engineers, or by other agencies, on the environmental effects of dredging and dredged material disposal. Within the past 15 years, major research has been conducted and is continuing in high-priority areas. The Corps has a three-element approach to better understanding the environmental impacts of dredging operations. Through the Dredging Operations Technical Support (DOTS) program, direct field assistance is available and a dredged material management program places the research developed in a user-oriented framework. Research is conducted under Long-term Effects of Dredging Operations Program (LEDO) and the Wetlands Research Program (WRP), while results are verified under the Field Verification Program (FVP). The Corps of Engineers has, through the Environmental Effects of Dredging Programs (EEDP), an innovative and active technology transfer program through the mechanism of providing direct technical assistance to the field, and a means to address high-priority research needs on a continuing basis. (Lantz-PTT)
W88-05909

## 5D. Waste Treatment Processes

**NEW ROUTES BUOY EFFORTS TO TRIM HEAVY-METAL WASTES,**
J. Chowdhury.
Chemical Engineering CHEEA3, Vol. 94, No. 14, p 26-27, October 12, 1987.

Descriptors: *Wastewater treatment, *Heavy metals, *Chemical treatment, Economic aspects, Industrial wastewater, Effluents.

The effectiveness of sodium hydroxide, lime and sodium sulfide for removing copper, zinc and nickel was compared. Besides precipitation efficiency, the experiments determined the volume, ease of settling and dewatering of the sludge generated with each reagent. The best results were produced by adjusting pH to slightly above neutral using lime, followed by treatment with sodium sulfide. For process streams that contain toxic organic compounds and heavy metals, a treatment method being developed which uses a complex substrate consisting of bacteria immobilized on diatomaceous earth, which in turn is coated with chitosan, a derivative of a polysaccharide found in the shells of marine crustaceans. A system of tubular filtration modules containing fluorinated hydrocarbon membranes can raise the concentration of suspended particles from 100 ppm to about 2-5%. The concentrate is then fed to a filter press, which dewaters it to 30-40% solids. (Alexander-PTT)
W88-05131

**OPTIMIZATION TECHNIQUES FOR SECONDARY WASTEWATER TREATMENT SYSTEM,**
Los Angeles County Sanitation Districts, Whittier, CA.
C. Tang, E. D. Brill, and J. T. Pfeffer.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 935-951, October 1987. 8 fig, 3 tab, 19 ref. Water Resources Center (Grant S-092-ILL).

Descriptors: *Secondary wastewater treatment, *Wastewater treatment, *Optimization, *Model studies, Decomposition, Activated sludge, Algorithms, Mathematical studies, Economic aspects.

Optimization approaches are shown to be effective in solving a comprehensive model of an activated sludge wastewater treatment system. A new decomposition approach tailored to take advantage of the special structure of the treatment system is presented. A liquid subsystem and a sludge subsystem are specified, and a series of subproblems is solved. Coordination of the solutions is then required. A widely used nonlinear programming algorithm (GRG2) and a geometric programming algorithm (IGGP) designed to handle equality constraints are also demonstrated. Each of the approaches is shown to produce efficient solutions for a test problem; computational requirements are similar. The first approach most clearly illustrates cost-effective trends and alternative solutions, while the third is most straightforward. The availability of the different approaches is important because one may be more suitable than the others for a particular application - especially if the model has been modified or extended. (See also W88-05159) (Author's abstract)
W88-05158

**COMPREHENSIVE MODEL OF ACTIVATED SLUDGE WASTEWATER TREATMENT SYSTEM,**
Los Angeles County Sanitation Districts, Whittier, CA.
C. Tang, E. D. Brill, and J. T. Pfeffer.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 952-969, October 1987. 1 fig, 3 tab, 41 ref. Water Resources Center Grant S-092-ILL.

Descriptors: *Activated sludge, *Wastewater treatment, *Optimization, *Model studies, Decomposition, Sludge, Algorithms, Mathematical studies, Economic aspects.

Comprehensive models of wastewater treatment systems are evolving and offer potential as tools for aiding engineers in developing cost-effective designs. These tools can be used for examining tradeoffs among unit processes, as well as issues such as reliability, safety factors, energy efficiency, and regional wastewater management. This paper presents a comprehensive model of a typical activated sludge wastewater treatment system operated at steady state. It includes both the liquid and solids portions of the treatment system and recycle streams. The model can be used in either an analysis mode or an optimization model. Three optimization algorithms have been shown to be effective. A complete formulation is given for one of them, the generalized reduced gradient (GRG) algorithm. Two example solutions are shown; one was obtained using an analysis program and one using GRG. Discussions of the optimization methods and of the potential uses of the model are provided in companion works. (See also W88-05158) (Author's abstract)
W88-05159

**EFFECT OF VARIABLE INFLUENT LOADING ON BIOLOGICAL PHOSPHORUS REMOVAL,**
Santa Clara Univ., CA. Dept. of Civil Engineering.
S. C. Chiesa, J. A. Postiglione, and M. Bjelland.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 1058-1073, October 1987. 5 fig, 3 tab, 26 ref.

Descriptors: *Phosphorus removal, *Wastewater treatment, *Biological wastewater treatment, Nutrients, Sludge disposal, Nitrogen, Phosphorus, Effluents, Metals, Stress, Biochemical oxygen demand, Process control.

Biological phosphorus (bio-P) removal processes are receiving increased attention as the costs and sludge disposal problems associated with traditional metal precipitation become of greater concern to system designers and operators. Biological processes, however, have not demonstrated the same ability as chemical processes to consistently produce effluents low in total phosphorus. The results of this investigation indicate that the dynamic biochemical oxygen demand (BOD) and phosphorus loading patterns observed at full-scale systems can impose varying degrees of stress on bio-P removal processes. Increases in the amount of loading-related stress on bench-scale bio-P systems are manifested by increases in long-term average effluent phosphorus concentrations. Effluent variability is magnified when activated sludge systems are operated for both nitrogen and phosphorus removal. Mitigating measures can be employed to improve long-term process performance, but at the cost of increased system complexity and increased sludge production. (Author's abstract)
W88-05166

**MECHANISM OF METAL REMOVAL IN ACTIVATED SLUDGE,**
Teesside Polytechnic, Middlesbrough (England). Dept. of Chemical Engineering.
T. Stephenson, P. S. Lawson, T. Rudd, R. M. Sterritt, and J. N. Lester.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 1074-1088, October 1987. 7 fig, 2 tab, 25 ref.

Descriptors: *Activated sludge process, *Metal removal, *Heavy metals, *Wastewater treatment, Cadmium, Copper, Nickel, Metals, Solubility.

Cadmium, copper, and nickel removals during the activated sludge process are investigated using a pilot scale plant. Cadmium and copper are predominantly insoluble in the settled sewage and have high percentage removal efficiencies. Nickel is mostly soluble in the influent and is poorly removed. Batch studies undertaken on mixed liquor samples at different solids concentrations indicate that a major removal mechanism for cadmium and copper is the interaction of particulate associated metal with the settleable biological solids, whereas uptake of soluble metal dominates for nickel. Titration of free metal ions with the mixed liquor solids and extracellular polymer indicates that the latter is responsible for some of the metal immobilization. The low resolubilization of copper by ethylenediaminetetraacetic acid and the calculated metal:ligand stoichiometry of less than unity indicate copper's high affinity for mixed liquor. Stoichiometries greater than unity for cadmium and nickel suggest that their removal is mechanistically dissimilar to copper. (Author's abstract)
W88-05167

**EFFECT OF AL(III) AND SULFATE ION ON FLOCCULATION KINETICS,**
Shipley Co., Inc., Newton, MA.
P. Sricharoenchaikit, and R. D. Letterman.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 1120-1138, October 1987. 9 fig, 1 tab, 30 ref. National Science Foundation Grant Number CEE-8315971.

Descriptors: *Wastewater treatment, *Kinetics, *Flocculation, *Polymers, *Sulfates, *Model studies, *Hydrodynamics, Particles, Ions, Mathematical studies, Coagulation, Aggregates.

The kinetics of orthokinetic flocculation of a dilute monodispersed polystyrene suspension initially coated with aluminum hydrolysis products (AHP) and destabilized by sulfate ion addition can be described by a modified Saffman and Turner kinetic model. The modifications include: (1) substituting for the collision efficiency parameter an expression which includes the effect of hydrodynamic forces, as well as double-layer repulsion and van der Waals attraction on the particle-particle interaction; (2) relating the volume fraction, Phi, to the amount of adsorbed AHP; and (3) assuming that the initially unadsorbed AHPs are deposited on the coated particle as a function of time after sulfate ion addition. The rate of uptake of AHP is assumed to be a function of hydrodynamic and surface chemical conditions; the AHPs are probably transported to the flocculating polystyrene particles as coagulating microcrystals or aggregating polymeric forms, and consequently Phi increases with time. (Author's abstract)
W88-05170

**CALCULATION OF EFFECTIVENESS FACTORS IN SPHERICAL SHELLS,**
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
D. K. Stevens, P. M. Berthouex, and T. W. Chapman.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 1149-1155, October 1987. 1 tab, 7 ref.

Descriptors: *Spherical shells, *Diffusion, *Wastewater treatment, *Bioreactors, *Model studies, *Mathematical studies, Orthogonal collocation, Equations, Effectiveness factors, Nitrification, Wastewater facilities, Fluidized bed process.

The problem of diffusion with reaction in a spherical shell has been solved approximately by collocation using asymmetrical polynomials that are orthogonal in the spherical shell. This approach gives accurate solutions and is computationally efficient in the sense that only a few collocation points are required. Symmetrical trial functions give much less accurate results. The proposed method was applied to the modeling of a fluidized bed nitrification reactor in which five species, including ammonium and oxygen, diffuse into and out of the biofilm shell and are involved in two highly nonlinear reactions. The film curvature parameter, eta, was on the order of 0.1 to 0.3 so that the geometrical effect was not negligible. One collocation point was sufficient for most cases studied, with resulting fast computation of steady state concentration profiles in the reactor. Dynamic experiments were also efficiently simulated. The efficiency of the method was particularly welcome for this unsteady state solution because the model consisted of more than one hundred simultaneous equations. Application of the collocation method transforms the second-order partial differential equations in space and time to a system of ordinary differential equations in time that can be integrated by standard initial value techniques. The method of orthogonal collocation using the proposed basis functions has been shown to be a powerful numerical technique for the solution of the continuity equation in a spherical shell geometry. The method of ordinates was easy to apply to the problem of multicomponent diffusion with nonlinear reaction such as arises for a fluidized bed nitrification reactor. A small number of terms is sufficient for most engineering calculations. In the effectiveness-factor example given, the numerical solutions converged to the analytical solutions with a small number of collocation points. The method is suitable for modeling most biofilm reactions and should also be useful for other two-phase processes. The use of basis functions tailored to the shell geometry was essential to the success of the calculation procedure. Further application to different geometries would make the orthogonal collocation method more broadly useful. (Alexander-PTT)
W88-05172

**IMPROVED SLUDGE GASIFICATION BY TWO-PHASE ANAEROBIC DIGESTION,**
Utah Univ., Salt Lake City. Dept. of Civil Engineering.
S. Ghosh.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1265-1284, December 1987. 5 fig, 10 tab, 14 ref. EPA Assistance Agreement CR-809982-01-1.

Descriptors: *Anaerobic digestion, *Wastewater treatment, *Sludge treatment, *Sludge digestion, *Gasification, *Two-phase anaerobic digestion, Effluents, Gases, Methane, Sludge, Wastewater, Acetogenesis, Methanogenesis, Hydrogen ion concentration.

The relative efficacies of two-phase and single-stage, high-rate anaerobic sludge digestion at mesophilic and thermophilic temperatures at several levels of hydraulic residence time (HRT), organic loading rate, and feed consistency were studied. In addition, the effects of pH, temperature, and HRT on acid-phase digestion were studied. Data from continuous-flow digestion studies showed that the two-phase process was better than single-stage digestion under all test conditions when compared on the basis of gas yield and production rate, reductions of volatile solids, carbohydrate-lipid-protein conversions, buffer-capacity, and unconverted volatile acids in the effluent. A mesophilic two-phase system exhibited about the same methane yield and solids reduction at a 3-day HRT as those of single-stage high-rate digestion at 15- and 17-day HRT's. The enhanced stability of two-phase digestion relative to single-stage digestion increased as the system loading and hydraulic dilution rates increased. Optimum hydrolysis and acidification occur at pH 6. Lipid and protein degradation products generated at 55 deg C inhibit acetogenesis and methanogenesis. (Author's abstract)
W88-05180

**NITRIFICATION IN POWDERED-ACTIVATED CARBON-ACTIVATED SLUDGE PROCESS,**
California Univ., Los Angeles. Dept. of Civil Engineering.
A. S. Ng, and M. K. Stenstrom.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1285-1301, December 1987. 11 fig, 4 tab, 37 ref. NSF Grant CEE 7911792.

Descriptors: *Wastewater treatment, *Activated carbon, *Nitrification, *Activated sludge, Ammonia, Organic compounds, Inhibition, Wastewater, Effluents.

Powdered activated carbon (PAC) has been added to activated sludge processes over the past 10 years to improve process performance in a variety of ways, including ammonia removal. Improved ammonia removal is a surprising benefit of PAC since it is not adsorbed. Investigators have speculated that PAC adsorbs inhibitory compounds or provides a medium for nitrifier growth. To ascertain the mechanism of nitrification enhancement, a series of experiments were performed with adsorbable (aniline, phenol) and nonadsorbable (ethanol) inhibitors. Adsorption of nitrification inhibitors dramatically improved nitrification rates in unacclimated activated sludge cultures. For adsorbable inhibitors, addition of PAC enhanced nitrification 75-97%; for relatively nonadsorbable inhibitors, nitrifications of 3-30% were observed at the same PAC dosage. These results support the theory that PAC can adsorb inhibitory compounds. The nitrification enhancement observed cannot be accounted for by any of the following mechanisms: (1) enhanced growth of nitrifiers on PAC surfaces; (2) increased trace nutrient or substrate concentration on the PAC surface; (3) heterotrophic acclimation and subsequent bioregeneration. (Alexander-PTT)
W88-05181

**EFFECT OF POND DEPTH ON BACTERIAL DIE-OFF,**
King Abdulaziz Univ., Jeddah (Saudi Arabia). Dept. of Civil Engineering.
H. Z. Sarikaya, A. M. Saatci, and A. F. Abdulfattah.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1350-1362, December 1987. 4 fig, 5 tab, 21 ref.

Descriptors: *Wastewater treatment, *Pond depth, *Stabilization ponds, *Coliforms, *Bacterial die-off, Effluents, Activated sludge, Model studies, Survival, Depth, Ponds, Bacteria, Mortality.

The depth dependence of bacterial die-off was demonstrated experimentally both in batch models and in three pilot-scale waste stabilization ponds with water depths of 0.5 m, 1.0 m, and 1.5 m. The dimensions of the ponds in plan were 1.0 x 2.0 m. The ponds were fed with secondary effluent of a two-stage trickling filter plant. An activated sludge treatment plant effluent was used in the batch models. The pond depth apparently had a significant effect on the coliform die-off rate. The first-order die-off rate constant was inversely proportional to the first power of the pond depth. (Author's abstract)
W88-05185

**DIFFERENCE IN SPOROGENOUS BACTERIAL POPULATIONS IN THERMOPHILIC (55 C) AND MESOPHILIC (35 C) ANAEROBIC SEWAGE DIGESTION,**
New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
M. Chen.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 10, p 2414-2419, October 1987. 1 fig, 5 tab, 23 ref.

Descriptors: *Sludge digestion, *Wastewater treatment, *Digestion, *Anerobic digestion, *Bacteria, *Spores, Thermophilic digestion, Mesophilic digestion, Fermentation.

Spores, sporeforming vegetative cells, and asporogenous populations were enumerated in two semicontinuous anaerobic fermentors digesting municipal primary sludge at 35 and 55 C for more than 87 days. In the 35 C fermentor, the anaerobic total population was 312.5 million/ml, with 25.0 million being sporogenous. The populations that digest casein, starch, pectin, and cellulose were 23.1 million, 59.2 million, 26.2 million, and 7.3 million per ml, respectively, with 2.8 million, 6.7 million, 3.4 million, and 1.5 million per ml being sporogenous, respectively. The sporeformers accounted for 8.0 to 20.0% of each of the respective populations. In the 55 C fermentor, the anaerobic total population was 512.5 million/ml, with 336.6 million/ml being sporogenous. The populations that digest casein, starch, pectin, and cellulose were 97.7 million, 190.7 million, 75.8 million, and 11.2 million per ml, respectively, with 47.8 million, 110.6 million, 43.3 million, and 5.1 million per ml, respectively, being sporogenous. The sporeformers represented 45.5 to 65.7% of each of the respective populations. The numbers of thermophilic sporeforming vegetative cells in the 55 C fermentor were 9.0 to 19.8 times higher than their counterparts in the 35 C fermentor. Most sporeformers were in the vegetative state in the 35 and 55 C fermentors. After 18 days of fermentation at 55 C, sporeformers carried out most of the digestion; however, the digestion was shared by both sporeformers and asporogenous bacteria after 87 days of fermentation. In the 35 C fermentor, asporogenous bacteria digested most of the sludge. During the 18- and 87-day experimental periods, sporeformers were never predominant. (Author's abstract)
W88-05190

**MEASUREMENT OF THE EFFECTS OF CADMIUM STRESS ON PROTOZOAN GRAZING OF BACTERIA (BACTERIVORY) IN ACTIVATED SLUDGE BY FLUORESCENCE MICROSCOPY,**
Louisville Univ., KY. Dept. of Biology.
R. L. Hoffman, and R. M. Atlas.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 10, p 2440-2444, October 1987. 5 fig, 33 ref.

Descriptors: *Water pollution effects, *Wastewater treatment, *Activated sludge, *Bacteria, *Protozoa, *Cadmium, Grazing, Aquatic animals, Sludge, Fluorescence microscopy, Bacterivory, Biological wastewater treatment, Heavy metals, Metals, Effluents.

The effect of cadmium stress on protozoan bacterivory in sewage sludge was measured by experimentally exposing sludge communities to 0 to 150 mg of Cd per liter for up to 6 hr and then determining the rates of protozoan grazing on bacteria, using a double-staining technique and epifluorescence microscopy. Bacterivory was measured by incubating the sludge with fluorescently labeled bacterium-sized latex beads and directly observing ingestion of the beads and bacterial cells in the sludge by epifluorescence microscopy of preserved samples. Staining with 4',6-diamidino-2-phenylindole and acridine orange permitted the simultaneous determination of protozoan numbers and bacterivory activity as estimated by the number of bacterial cells and bacterium-sized latex beads ingested by the representative ciliate Aspidisca costata. Enumeration with latex beads proved to be an effective way of estimating bacterivory in sludges subjected to heavy-metal stress. This technique should prove useful for determining the effects of other chemical stresses on protozoan numbers and bacterivory in organic-rich environments. Although the number of protozoa declined significantly only after exposure to 100 mg of Cd per liter for 4 hr, grazing, as indicated by bead ingestion, was significantly inhibited by Cd concentrations of $>25$ mg/liter in $<1$ hr, and exposure to 100 mg of Cd per liter effectively stopped protozoan grazing within 1 hour of exposure. Protozoan ingestion of latex beads and bacteria was inversely correlated to Cd concentration and exposure time. The reduction of protozoan bacterivory by Cd provides a possible explanation for the increase in suspended bacteria in the effluents of metal-stressed treatment facilities (Author's abstract)
W88-05193

**BIOLOGICAL ACTIVATED CARBON AS TERTIARY TREATMENT FOR MUNICIPAL-INDUSTRIAL WASTEWATER,**
Texas Univ. at Dallas, Richardson. Center for Environmental Studies.
R. P. Smith.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8627550. Ph.D Dissertation, 1986. 457 p, 125 fig, 80 tab, 107 ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Municipal wastewater, *Biological wastewater treatment, *Activated carbon, *Tertiary wastewater treatment, Oxygenation, Oxidized wastewater, Pilot plants, Ozonation, Aeration.

The role of empty bed contact time (EBCT), flow mode, ozone dose, and other oxygen enhancing pretreatments of biological-activated carbon (BAC) as a tertiary treatment was studied at a municipal wastewater treatment facility. EBCT of from 8 to 32 minutes was studied on one set of pilot plants, and pretreatment of wastewater before granular-activated carbon (GAC) was studied on a second set. Pretreatments were aeration to 6 mg/L dissolved oxygen (DO), oxygenation to 20 mg/L DO, and ozonation at 10 mg/L applied ozone dose using oxygen as the ozone feed gas. For secondary biological wastewater effluent with BOD5 of 20 mg/L and TSS of 15 mg/L, BAC achieved sustained performance of 10 mg/L BOD5 and 4 mg/L TSS. This performance can be met for at least one year at an EBCT time of 8 minutes or greater. No significant differences in water quality between pretreatment with oxygen or oxygen-ozone (10 mg/L applied ozone dose) were observed, demonstrating that the main benefit of oxygen-ozone was the oxygen component. Pretreatment with oxygen or oxygen-ozone resulted in nitrification, achieving 85% ammonia reduction, from 10 mg/L to 1 mg/L or less. Oxygen pretreatment prior to GAC contact at 20 minutes EBCT achieved consistent effluent water quality of 2 mg/L TSS and 6 mg/L BODS. (Cremmins-AEPCO)
W88-05208

**ENVIRONMENTAL MANAGEMENT OPTIONS IN THE CONTROL OF WATER RELATED DISEASES IN THE LAGOS METROPOLITAN AREA OF NIGERIA,**
Oklahoma State Univ., Stillwater. Graduate Coll.
For primary bibliographic entry see Field 5G.
W88-05209

**GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION OF WASTEWATER TREATMENT SLUDGES AND RIVER SAND TO BE USED AS SANITARY LANDFILL CAPS,**
Kent State Univ., OH. Dept. of Geology.
For primary bibliographic entry see Field 5E.
W88-05218

**PROCESS OF INNOVATION IN RURAL WASTEWATER TREATMENT,**
State Univ. of New York at Albany. Coll. of Environmental Science and Forestry.
M. A. Rechlin.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8626119. Ph.D Dissertation, 1986. 238 p, 13 fig, 10 tab, 47 ref, 7 append.

Descriptors: *Wastewater treatment, *Rural areas, *Technology transfer, *Local governments, Model studies, Regulations, Legal aspects, Cost analysis, Water quality, Literature review.

Six communities in rural New York State that pursued innovative wastewater treatment technologies were investigated as case studies. Four of the communities had been successful in implementing innovative technologies and the other two communities were either totally or partially unsuccessful. The literature was reviewed and a theoretical model for the process of innovation in local government was developed. The findings of the study were compared with the theoretical model. The findings indicate that the consulting engineer is central to the innovation process. The research substantiates earlier findings about the key role of an interpreter in the decision and implementation process. This role is often left unfilled in a small community setting. Regulatory review tends to dampen innovation and to add to the costs of the project. Meeting the plethora of mandates and review processes substantially delays project implementation and dramatically adds to the costs. Having someone inside the regulatory structure to act as a project advocate or facilitator is beneficial

to the timely implementation of the project. (Cremmins-AEPCO)
W88-05220

**TAILORING FLOCCULANT MOLECULAR STRUCTURE TO IMPROVE THE CONDITION AND DEWATERING OF WASTEWATER SLUDGES,**
Rose-Hulman Inst. of Tech., Terre Haute, IN.
J. A. Caskey, and D. Worthington.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-139787/AS. Price codes: A03 in paper copy; A01 in microfiche. Project No. USGS G1224-02. Contract No. 14-08-0001-G1224. Indiana Water Resources Research Center, W. Lafayette, Technical Report No. 179, September 1987. 39 p, 15 fig, 24 ref.

Descriptors: *Wastewater treatment, *Water treatment, *Sludge treatment, *Polymers, Pollution control, Water quality control, Sludge, Dewatering, Conditioners, Polyacrylamide molecular structure.

The objective of this project was to determine the most effective polyacrylamide molecular structure to condition municipal sewage sludges. Linear and branched polymer with a molecular weight range from 70,000 to 1,500,00 was studied. Polymer effectiveness was determined using a capillary suction test apparatus and a Buchner funnel specific resistance apparatus. The capillary suction test apparatus was modified to increase the precision of the instruments. It was found that the same results were obtained using either the capillary suction test or the Buchner funnel test apparatus for collecting data. Polymer was used to condition three types of sludges: A 10% kaolin sludge, raw primary sludge, and a mixed digestor sludge. In all cases the linear polymer was more effective than branched polymer of the dame molecular weight. In every case tested an optimum polymer dose was found. For molecular weights up to 1.5 million increasing the molecular weight increased the effectiveness of the polymer. (Cushman-Purdue U., WRRC)
W88-05237

**MODULAR ROCK REPLACING DRAIN FIELD APPARATUS,**
For primary bibliographic entry see Field 5E.
W88-05242

**SLUDGE SETTLING PLANT,**
IBM, Paris (France). Paris Scientific Center.
R. Riker.
U. S. Patent No. 4,578,189; March 25, 1986, 5 p, 6 fig. Official Gazette of the United States Patent Office, Vol 1064, No 4, p 1774, March 25, 1986.

Descriptors: *Patents, *Settling tanks, *Sludge conditioning, *Wastewater treatment, Suspended solids, Settling velocity, Weirs, Sludge solids, Wastewater facilities.

A sludge settling plant comprises tanks connected in parallel in the flow path and overflow weirs disposed between the settling tanks. At least two of the tanks are disposed beside each other and are defined by at least three parallel longitudinal walls, a continuous end wall, and upwardly inclined ramps opposite to the end wall. An inlet duct is provided for each settling tank. The ducts are connected by at least one valve to a common supply line. An overflow weir and discharge trough extend along part of each longitudinal wall. Because the total length of the overflow weirs is substantially increased and the cubic capacity of the settling plant is not increased, the flow velocity across the weirs is reduced to a fraction of an order of 5 to 10% of the normal values. The settling tanks have a greatly improved settling effect, since the ability of suspended solids to settle is inversely proportional to the flow velocity. When processing sludges containing solids having a particle size no greater than 0.2 mm in the settling plant, 95 to 97% of the solids will settle in the primary settling tanks. The water leaving the tanks is purified to a high degree that is usually sufficient to provide a single additional collecting tank from which clarified water can be withdrawn. (Cremmins-AEPCO)
W88-05243

**BIOLOGICAL PHOSPHORUS REMOVAL IN FRANCE,**
M. Florentz, D. Caille, F. Bourdon, and J. Sibony.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1171-1173, 1987. 3 fig, 4 ref.

Descriptors: *Phosphorus removal, *Biological wastewater treatment, *Wastewater treatment, *France, Activated sludge, Phosphorus, Wastewater facilities, Sludge, Phosphorus compounds, Nuclear magnetic resonance.

Sewage treatment, including biological phosphorus removal, at the facility of Saint Mars la Jaille in western France is described. The sewage treatment plant receives about 900 cu m of wastewater/day with BOD, total nitrogen and total phosphorus concentrations of approximately 450, 45 and 20 milligrams/liter, respectively. The original facility consisted of a single reactor with a pair of low-speed vertical shaft surface aerators controlled by an oxygen probe. An anaerobic reactor was added into the treatment line for the release of phosphorus from activated sludge and a mechanical stirrer was added to mix the anaerobic activated sludge. Before the additions, phosphorus removal was 35-40%; this increased to 68-92% with the addition of the anaerobic stage. Nitrification-denitrification processes are mentioned briefly since the presence of nitrates has a detrimental effect on phosphorus release. Polyphosphates accumulated in activated sludge was identified by 31P nuclear magnetic resonance. (Wood-PTT)
W88-05245

**MICRO-ORGANISMS IN SEWERAGE SYSTEMS AND THEIR SIGNIFICANCE FOR WASTEWATER TREATMENT,**
Technische Hochschule Aachen (Germany, F.R.). Inst. fuer Siedlungswasserwirtschaft.
B. Schurmann.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1185-1187, 1987. 4 fig.

Descriptors: *Sewage bacteria, *Microorganisms, *Wastewater treatment, *Sewer systems, Municipal wastewater, Bacteria, Wastewater facilities, Wastewater, Sewers, Metabolism.

Layers of microorganisms develop on sewer pipe walls and reduce the level of pollution of municipal wastewater in sewer systems. The composition of the layer depends on the quantity, complexity and velocity of the sewage and its thickness varies from 0.5 millimeters to several centimeters. Magnification of the microbial film found on pipe walls and floating freely in sewer systems leading to sewage treatment plants revealed bacterial flocs which may reduce the BOD5 by up to 30% between sewage discharge from a household and arrival at a treatment plant. It was almost impossible to distinguish flocs in the sewage system from typical bacterial flocs from a high loaded activated sludge plant, indicating that the metabolic activity of the bacteria in the sewer system must be considered when designing improvements to a sewage system. Since several of the bacterial groups identified in municipal sewage treatment plants can also inhabit human intestines, it is recommended that the life cycle of bacteria in humans, the sewage system and sewage water treatment facilities be studied as a whole. (Wood-PTT)
W88-05249

**USE OF WATER QUALITY MODELS IN BELGIUM,**
Brussels Univ. (Belgium). Lab. of Hydrology.
For primary bibliographic entry see Field 5G.
W88-05252

**ELECTRO-IMPULSE SLUDGE STABILIZATION,**
Gesellschaft fuer Klaranlagenausrustung und Energieverwertung m.b.H., Gladbeck (Germany, F.R.).
N. J. Dichtl.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1203-1206, 1987. 2 fig, 1 tab, 9 ref.

Descriptors: *Sludge stabilization, *Electrical pulses, *Sludge digestion, *Bacteria, *Wastewater treatment, Municipal wastes, Electricity, Sludge, Economic aspects, Disinfection, Digestion, Biodegradation.

The possibility of influencing the growth and metabolism of bacteria by electricity has been known for about 100 years. However, the development of this in practice in order to obtain positive effects on wastewater treatment or sludge stabilization has not occurred. Experiments on a semi-technical scale were formulated and carried out whereby two digesters containing municipal raw sludge were run with detention periods of 15 or 20 days at 33 degrees C. While one digestion process was operated as usual, the other was influenced by electro-impulse condenser discharge. Clearly positive effects were obtained, especially with regard to increased gas production as well as a reduced H2S content in the digestion gas. Considering the necessary investment and running costs, the method seems to be a significant complement to sludge digesters. (Author's abstract)
W88-05253

**ACTIVATED SLUDGE PROCESS CONTROL BY BEHAVIOUR OF SECONDARY SETTLING TANKS,**
Naples Univ. (Italy). Facolta di Ingegneria.
G. d'Antonio, and P. Carbone.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1207-1210, 1987. 2 fig, 3 ref.

Descriptors: *Activated sludge process, *Process control, *Wastewater treatment, *Mathematical models, *Data interpretation, Model studies, Mathematical studies, Mathematical equations, Activated sludge, Settling tanks, Kinetics, Sludge, Sludge recycling, Organic loading, Suspended solids.

Mathematical models of activated sludge kinetics and solids flux were investigated; the constants were derived experimentally. Variations in influent organic load in an activated sludge plant are usually absorbed by changing the sludge recycle ratio (R) to increase the concentrations of suspended solids in the aeration tank. The limiting solids flux of the secondary settling tank is related to R, putting limits on the procedure. Two models of the kinetics of biological removal of organics and solids flux were compared and it was shown that R is a parameter of the control of the process. Appropriate mathematical equations are presented and used to plot an operational chart from which, for given aeration and settling tank volumes, it is possible to: (1) determine the parameters of the process (suspended solids concentration) for a given sludge age and for different characteristics of the influent flow rate, (2) evaluate the flexibility of the treatment facility in its ability to absorb organic load increases without design changes, and (3) determine conditions that lead to process failure and to estimate the variations to be made to the sludge age. (Wood-PTT)
W88-05254

**EFFECT OF ACTIVATED CARBON PORE STRUCTURE ON ACTIVATED SLUDGE PROCESS PERFORMANCE,**
Higher Inst. of Chemical Technology, Burgas (Bulgaria). Dept. of Water Technology.
I. Dobrevsky, and L. Zvezdova.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1215-1217, 1987. 1 fig, 3 tab, 6 ref.

Descriptors: *Activated sludge process, *Activated carbon, *Pore size, *Wastewater treatment, Pores, Process performance, Enzymes, Bacteria, Microorganism, Bioregeneration, Adsorption, Wastewater.

The effect of activated carbon pore structure on activated sludge process performance was investigated using carbons whose pore volume, pore radius and surface area were measured using mercury intrusion and BET methods. The adsorptive characteristics and soluble chemical oxygen demand removal abilities were determined and it was shown that simple adsorption cannot explain

the post-addition effect of carbons after equilibrium was established (1.5 hours), when the adsorptive capacities should have been exhausted. The behavior is consistent with the theory of biological regeneration of activated carbon, although evidence suggests that there is no correlation between adsorptive capacity of the carbons and purification effect under the conditions studied. Experimental data indicates that the carbon pore structure is an important parameter in the bioregeneration process. Because the pore size of the carbons studied was smaller than bacterial cells (5000-10,000 A), the bacteria themselves cannot be located in the pores. However, a great number of micro-organisms produce extracellular enzymes which act independently of the bacterial cells and which may, because of their smaller size, diffuse into pores of 50-1000 A causing substrate decomposition. Thus, the carbon studied which had the highest volume of pores with average diameter of 50-1000 A was the most efficient for wastewater treatment since the effluent quality depends on the process of bioregeneration. (Wood-PTT)
W88-05255

**ANAEROBIC-AEROBIC VERSUS AEROBIC TREATMENT OF CONCENTRATED PULP AND PAPER MILL EFFLUENT,**
Tampere Univ. of Technology (Finland). Dept. of Civil Engineering.
P. Vuoriranta, J. Rintala, and H. Morange.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1219-1221, 1987. 4 tab.

Descriptors: *Anaerobic digestion, *Anaerobic pretreatment, *Aerobic digestion, *Anaerobic-aerobic digestion, *Wastewater treatment, *Pulp wastes, Industrial wastewater, Biological wastewater treatment, Activated sludge process, Organic loading.

Progress in the anaerobic biological treatment of pulp and paper industry wastes has been made, but anaerobic treatment alone cannot usually produce effluents which meet the established requirements. However, anaerobic treatment when used as a pretreatment to aerobic digestion, affects the quality of wastewater needing aerobic treatment and, therefore, the performance of the aerobic treatment. The feasibility of pretreating concentrated fractions of pulp and paper mill effluent anaerobically before subjecting them along with the dilute effluent fractions to a final purification stage was investigated. The anaerobic-aerobic and single stage aerobic treatment processes were compared. The results showed that the anaerobic pretreatment removed high organic loads efficiently from a concentrated thermochemical pulp wastewater fraction. Anaerobic-aerobic combinations produced stable effluent. The quality of the effluent produced if the anaerobic stage were to temporarily fail to remove the organic load efficiently, was good enough that most of the remaining load could easily be removed in the following activated sludge process. When it followed anaerobic digestion, the activated sludge process produced less surplus sludge with better settling properties than the single stage activated sludge process. (Wood-PTT)
W88-05256

**ELIMINATION OF SULFIDES AND CONTROL OF HYDROGEN SULFIDE ODORS AT A SCREWPELLER PUMPING STATION,**
F. F. Coutinho.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1223-1227, 1987. 2 fig, 2 tab.

Descriptors: *Sewer systems, *Sulfides, *Sulfide elimination, *Wastewater, *Odor control, Pumping plants, Archimedean screws, Odors, Rio de Janeiro, Brazil, Chemical reactions, Oxidation, Sulfuric acid.

Sewage from areas south of the City of Rio de Janeiro is transported in a long gravity interceptor to a screwpeller (Archimedean screw) lift station which was constructed in 1973 to deliver the collected sewage to a main pumping station for further transport to the Ipanema submarine outfall. The gradient of the 7.7 km long interceptor and pumping station capacity are insufficient to prevent the formation of sulfide; wastewater entering the screwpeller lift station had high values of dissolved sulfide (up to 6.4 mg/liter). The pumping action released hydrogen sulfide gas into the interior of the station. The gas then escaped and created a strong, disagreeable odor in the neighborhood which consisted of highly-priced residential apartments, hotels and restaurants. A simple solution to the problem was devised. It involved the complete sealing of the station and manholes on the discharge pipeline to eliminate the release of hydrogen sulfide into the surrounding atmosphere, and the installation of a 100 mm diameter PVC plastic pipeline to connect the first entrance manhole on the discharge side of the screwpeller station to the inlet pipe. The pipeline functions as a reactor to permit the combination of influent sulfides with the oxygen obtained by the entrainment of air by the pumps. Since the reaction of the undesirable hydrogen sulfide and oxygen produced sulfuric acid, the effects of the acid on the interior of the pumping station were investigated and found to be insignificant after twelve years of operation. (Wood-PTT)
W88-05257

**OPTIMIZATION OF FLOCCULATION/FLOTATION IN CHEMICAL WASTEWATER TREATMENT,**
Norsk Hydroteknisk Lab., Trondheim.
H. Odegaard.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1233-1236, 1987. 1 tab, 9 ref.

Descriptors: *Flocculation, *Flotation, *Chemical treatment, *Wastewater treatment, Chemical coagulation, Optimization, Wastewater, Chemical precipitation, Sedimentation, Design criteria.

Wastewater treatment by chemical precipitation consists of a very fast reaction process, the precipitation of soluble and colloidal substances, followed by two or more slower particle separation processes: particle aggregation (flocculation) and floc separation by sedimentation, flotation and/or filtration. Flocculation involves the preparation of flocs for easy separation; it is postulated that flocs which will be floated should require different preparation from those which will be settled. According to current practices, flocculation units which are followed by flotation tanks are designed and operated in the same way as those followed by sedimentation tanks. Therefore, the optimum conditions for flocculation units coming before flotation units in the treatment system were investigated and design recommendations for a flocculation/flotation system for the chemical treatment of pre-settled sludge are presented. It was determined that flocculation units preceding flotation units should, indeed, be designed and operated differently from those preceding sedimentation units; the values of the mean turbulent velocity gradient (G) should be considerably higher in flocculation/flotation systems than in flocculation/sedimentation systems and tapering of the G value is favorable in the flocculation/sedimentation but not in the flocculation/flotation systems. Design criteria recommended for flocculation/flotation systems when used in chemical precipitation include: (1) theoretical mean residence time at design flow of 25-30 minutes, (2) flocculator residence time distribution which is as similar to plug flow as possible, (3) values of G for each flocculator which are equal and in the order of 60 to 80/sec, and (4) pressurized water amount equal to 15-20% (recirculation ratio) of design flow when the pressure is 0.5 MPa. Hydraulic load in the flotation unit is also discussed. (Wood-PTT)
W88-05259

**WASTEWATER TREATMENT WITH POWDERED CARBON AND WET OXIDATION REGENERATION,**
Budapesti Mueszaki Egyetem (Hungary). Dept. of Agricultural Chemical Technology.
J. Kalman, and I. Szebenyi.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1237-1238, 1987.

Descriptors: *Activated sludge process, *Activated carbon, Activated sludge, *Wastewater treatment, *Pharmaceutical wastes, Industrial wastes, Adsorbents, Regeneration, Thermal regeneration, Wet oxidation process, Oxidation, Chemical oxygen demand.

Wastewater treatment with activated sludge is common. Previously described technologies all require the addition of virgin activated carbon, at considerable cost, to replace the activated carbon lost in the process. The use of spent waste activated carbon obtained from the pharmaceutical industry solves both the problem of eliminating pharmaceutical wastes and providing an inexpensive source of carbon for wastewater treatment. The activated carbon was regenerated by thermal and wet oxidation methods; both methods afford an adsorbent with significant adsorption capacity. According to the results of experiments with activated carbon/activated sludge systems, activated carbon regenerated by wet oxidation was more effective than that obtained by the thermal method. The COD of water treated with activated sludge decreased considerably upon addition of activated carbon powder which was also especially effective in the removal of bioresistant compounds. (Wood-PTT)
W88-05260

**TWO STAGE SLUDGE STABILIZATION,**
Gesellschaft fuer Klaranlagenausrustung und Energieverwertung m.b.H., Gladbeck (Germany, F.R.).
N. J. Dichtl.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1247-1250, 1987. 2 fig, 4 ref.

Descriptors: *Sludge stabilization, *Sludge digestion, *Wastewater treatment, *Multistage sludge digestion, Aerobic digestion, Anaerobic digestion, Wastewater pretreatment, Disinfection.

Theoretical considerations were used to develop a multiple-stage method for the stabilization of sludges and to determine its advantages and disadvantages. Combinations of mesophilic digestion preceded by aerobic-thermophilic, aerobic-mesophilic, or anaerobic-thermophilic preliminary treatment were performed at a technical pilot scale and the results were compared with those from one-stage mesophilic digestion. All three two-stage procedures have advantages over the one-stage method with regard to process stability, dewatering behavior, gas production, and necessary reaction volume. No separate disinfection is needed for stabilized sludge intended for agricultural use if temperatures in the thermophilic range are used in the preliminary stage. The multi-stage methods require a little more work and have slightly higher operational costs than the one-stage method. (Wood-PTT)
W88-05263

**SIMPLE WASTEWATER TREATMENT SYSTEM INCORPORATING THE SELECTIVE CULTIVATION OF A FILAMENTOUS ALGAE,**
National Inst. for Water Research, Pretoria (South Africa).
A. Wood.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1251-1254, 1987. 3 fig.

Descriptors: *Algae, *Filamentous algae, *Algal harvesting, *Wastewater treatment, Ponds, Pollution load, Retention times, Infection, Bacteria, Organic loading, Gravel, Fish, Ammonia, Chemical oxygen demand, Phosphorus removal, Suspended solids.

The development of high rate pond systems to systematically enhance algal growth as a cheap, simple wastewater treatment technology was handicapped by the inability to find a reliable and cost effective method of harvesting the algae. The use of easily harvestable filamentous algae in the process of wastewater treatment, biomass recovery and water reclamation was investigated in association with simple pretreatment stages to reduce the pollutant load to the pond system. By operating at short hydraulic retention times, algae smaller than the screen mesh size of 200 micrometers are washed out into the effluent stream and, therefore,

not established in the pond. Algae larger than 200 micrometers, such as the filamentous Stigeoclonium, are retained and easily harvested by passing over a 250 micrometer wedge wire screen prior to drying in the sun. The initial problem of almost total destruction of the filamentous algal culture by chironomid larval infections and overrunning of the culture by bacteria and particulates were solved by reduction of organic loading by passing the effluent through a coarse gravel bed and introducing biological control in the form of tilapia, carp and barble fish to the pond. Before implementing the selective screened principle for filamentous algae cultivation, the pond had operated as a unicellular high rate pond receiving untreated raw wastewater at hydraulic retention times ranging from 2.5 to 7 days; dissolved COD was reduced 40%, ammonia 56%, phosphate 33%, total COD 48%, and total Kjeldahl nitrogen 46%. The modified algal system attained removals of approximately 63%, 52%, 75%, and 84% for ammonia, phosphate, suspended solids, and total COD, respectively. (Wood-PTT)
W88-05264

**SENSITIZED PHOTOOXIDATION FOR WASTEWATER DISINFECTION AND DETOXIFICATION,**
Tennessee Technological Univ., Cookeville. Dept. of Engineering Science and Mechanics.
T. N. Eisenberg, E. J. Middlebrooks, and V. D. Adams.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1255-1258, 1987. 6 fig, 1 tab, 1 ref.

Descriptors: *Oxidation process, *Wastewater treatment, *Disinfection, *Detoxification, *Water reuse, Wastewater, Feasibility studies, Sensitizers, Economic aspects, Ponds, Mixing, Hydrogen ion concentration, Temperature effects, Dissolved oxygen, Suspended solids, Detention time.

In order to provide information needed to design a full-scale sensitized photooxidation system for the disinfection and detoxification of wastewater, the following tasks were performed: (1) determination of the feasibility of such a system in a full-scale situation, (2) determination of the effects of mixing, sunlight intensity, pH value, reactor depth, sensitizer and sensitizer concentration, initial substrate concentration, dissolved oxygen concentration, water and air temperature, suspended solids and turbidity, and hydraulic detention time on disinfection and detoxification efficiency, (3) development of mathematical models to predict and optimize disinfection and detoxification efficiencies, (4) documentation and resolution of operational and process control difficulties. Results of bench- and pilot-scale experiments show that sensitized photooxidation is an effective treatment process for wastewater disinfection and detoxification with several advantages over other methods. Because sensitizers absorb energy in the visible spectral region, sunlight serves as a no-cost energy source for the process, and energy costs for such systems are minimal. The sensitizer is regenerated in the process, and only low concentrations are required. Unlike chlorination, toxic chlorinated organics are not formed. Structural facilities (ponds) and instrumentation associated with these systems are relatively inexpensive and are simple to design, construct, operate, and maintain. The required contact time for disinfection is relatively short. Sensitized photooxidation is a low cost, low technology treatment process that can help facilitate water reuse. (Wood-PTT)
W88-05265

**BIOLOGICAL ASPECTS IN THE EVALUATION OF TERTIARY LAGOONS AND EFFICIENCY IN THE REMOVAL OF ORGANIC POLLUTANTS,**
SITEL, Triunfo (Brazil).
For primary bibliographic entry see Field 5A.
W88-05266

**ALKALINITY AND PH CHANGES IN THE ACTIVATED SLUDGE PROCESS,**
Universidade Federal da Paraiba, Campina Grande (Brazil). Dept. of Civil Engineering.
A. C. van Haandel, and P. F. C. Catunda.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1263-1264, 1987. 2 fig.

Descriptors: *Activated sludge process, *Hydrogen ion concentration, *Alkalinity, *Wastewater treatment, Chemical properties, Mathematical equations, Theoretical analysis, Ammonification, Nitrification, Denitrification, Nitrogen compounds.

The theoretical alkalinity change in the activated sludge process due to three reactions of influent nitrogenous material can be calculated from simple stoichiometry: per mg N, ammonification (hydrolysis of organic nitrogen to saline ammonia) and denitrification (reduction of nitrate to molecular nitrogen) cause alkalinity increases of 3.57 mg CaCO3, whereas nitrification (oxidation of saline ammonia to nitrate) causes a decrease of 7.14 mg CaCO3. The three separate equations for the effects of ammonification, nitrification, and denitrification were added together to produce one equation which represents the combined effect of reactions of nitrogenous material on alkalinity. The alkalinity for the carbonic system (the prevailing buffer in mixed liquor) was also defined by equations which related alkalinity to pH for different CO2 concentrations. (Wood-PTT)
W88-05267

**FREEZE-DRIED CULTURE: AN EFFICIENT SEED TO ALLOW FAST START-UP OF A NITRIFICATION FILTER,**
Lyonnaise des Eaux, Le Pecq (France). Lab. Central.
D. Bertini, J. M. Audic, J. M. Navarro, and G. M. Faup.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1265-1268, 1987. 2 fig, 1 tab, 6 ref.

Descriptors: *Freeze drying, *Bacteria, *Nitrification, *Biological filters, *Wastewater treatment, *Water treatment, Drinking water, Filters, Wastewater, Seeding.

For both wastewater and drinking water treatment, a period of several weeks is required before obtaining correct nitrification when biological nitrification plants are initially commissioned or when they are restarted after a prolonged shutdown. Therefore, Nitrobacter winogradskyi serotype agilis bacteria were freeze dried and used to seed columns to determine the effect on start-up time. Freeze dried and untreated bacteria were also compared with respect to their attachment on granular support. Columns seeded with freeze dried bacteria immediately showed higher oxidation rates than the control columns which were colonized by the same type of organisms, but without freeze drying, indicating that the method is effective in nitrification filters. (Wood-PTT)
W88-05268

**CONTAMINATION OF GROUNDWATER BY SEPTIC TANK PERCOLATION SYSTEMS,**
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl und Pruefamt fuer Wasserguetewirtschaft und Gesundheitsingenieurwesen.
For primary bibliographic entry see Field 5B.
W88-05270

**LOW COST INDIVIDUAL SANITATION IN DEVELOPING COUNTRIES: METHODOLOGY FOR THE TESTING OF DOUBLE VAULT COMPOSTING LATRINES IN IVORY COAST,**
Universite Nationale de Cote d'Ivoire, Adidjan. Faculte de Pharmacie.
R. Macia, L. Kouadio, A. Rambaud, and H. Philip.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1281-1285, 1987. 6 fig, 1 tab.

Descriptors: *Composting latrines, *Wastewater treatment, *Composting, *Domestic wastewater, *Developing countries, *Domestic wasteater, *Testing procedures, Sanitation, Sanitary engineering, Ivory Coast, Monitoring.

Because there are no data reported on the physicochemical aspects of the double vault composting latrine, the determination of sizing and optimal operating conditions which allow rapid composting with the fewest health risks has been difficult. A monitoring methodology was proposed for the biological reactor formed by the dry composting tank. Six urban sites and six rural sites in Ivory Coast were chosen for testing. The monitoring method required the following in situ measurements: (1) rate of filling, determined using a gauge at 6 holes in the slab and the utilization and ventilation apertures, (2) temperature, measured with a thermocouple fixed to the end of a metal rod 2 meters long, and (3) pH, measured using a field pH meter at two points: the utilization and ventilation apertures. In the laboratory, water content was measured by oven drying at 105 degrees C, mineral substance was determined from residue formed by heating to 525 degrees C, organic matter was calculated, and nitrogenous compounds were measured. The monitoring method appears acceptable after 7 months of experimental work. (Wood-PTT)
W88-05271

**ROLE AND PERFORMANCE OF SEPTIC TANKS IN INDIVIDUAL SANITATION: EFFECT OF BIOLOGICAL ACTIVATORS,**
Societe Eparco, Paris (France).
H. Philip, A. Rambaud, and J. Bontoux.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1287-1289, 1987. 4 fig.

Descriptors: *Septic tanks, *Wastewater treatment, *Biological activators, *Operating conditions, Anaerobic digestion, Sludge, Digestion, Effluents, Optimization, Adsorbents, Sludge volume, Pretreatment of wastewater, Domestic wastes, Biological wastewater treatment.

Septic tanks play two roles in sewage treatment in independent sanitation systems: (1) protection of the percolating system by retention of solid matter (hydraulic phenomenon), and (2) liquifaction of sludge by anaerobic digestion (biological phenomenon). The characteristics of satisfactory effluent indicating proper hydraulic and biological operating conditions are listed. At 15 degrees C, biological sludge digestion phenomena stabilize only after 2 years of operation, but methanization is not rapid enough in septic sludge to eliminate the volatile fatty acids produced. Use of a biological activator, a mineral adsorbent with high specific area that fixes bacteria and enzymes, can accelerate hydrolysis and methanization and maintain biological activity within operating limits. Besides accelerating digestion phenomena, biological activators reduce sludge volume and reduce disturbances caused by variations in operating conditions. (Wood-PTT)
W88-05272

**ENERGY SAVINGS BY OPTIMIZATION OF ACTIVATED SLUDGE AERATION,**
Water Research Centre, Stevenage (England).
A. D. C. Cantwell.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1291-1292, 1987.

Descriptors: *Activated sludge processes, *Optimization, *Aerobic digestion, *Wastewater treatment, Operating costs, United Kingdom, Activated sludge, Economic aspects, Costs.

The energy used for aeration in activated sludge systems is sometimes as high as 80% of the total process requirement and amounts to about 4 times 10 to the 8th power kWH/yr in the United Kingdom. Optimization of design and operation in plants with low aeration efficiencies, would reduce energy costs. Specific causes of insufficient aeration efficiencies and suggestions for design improvements presented. Results obtained from a full-scale plant indicate that fine bubble, diffused air systems are capable of high aeration efficiency in plants designed to produce highly nitrified effluents; however, an anoxic zone for denitrification must be included at the aeration tank inlet. Mechanical aeration systems were potentially more efficient in systems designed to produce non-nitrified effluents. (Wood-PTT)
W88-05273

**NEW CONCEPT IN CLARIFIERS,**
Smally, Wellford and Nalven, Inc., Sarasota, FL.
W. C. Parsons.
Public Works PUWOAH, Vol. 118, No. 10, p 61-62, October 1987.

Descriptors: *Wastewater treatment, *Impaired water use, *Clarifiers, Central County Utilities, Sarasota, Florida, Oxidation ditches, Boat clarifier, Wastewater irrigation, Filtration, Golf courses, Sludge digestion, Biological treatment.

A boat clarifier (with rotor aerators) was used in an oxidation ditch system in a 1 mgd private franchise treatment plant near Sarasota, Florida. The boat clarifier uses the energy of the water movement within the ditch to separate sludge from the water, making external clarifiers and return sludge pumping unnecessary. The mixed liquor enters the stern of the clarifier and is pulled forward by the negative head generated by the sludge ports. Effluent from the boat clarifier flows to a continuous backwash, upflow, deep bed granular media filter which is cleaned by recycling the sand through an airlift and sand washer. Prolonged aeration of sludge in the digester produces an odorless product. The effluent is chlorinated and used to irrigate a golf course. (Cassar-PTT)
W88-05343

**ACHIEVING TWO GOALS WITH BIOLOGICAL-CHEMICAL PHOSPHORUS REMOVAL,**
Kennedy/Jenks/Chilton, Inc., San Francisco, CA.
L. E. Peirano, and L. G. Parlin.
Public Works PUWOAH, Vol. 118, No. 10, p 74-77, October 1987. 4 fig, 1 tab.

Descriptors: *Wastewater treatment, *Phosphorus removal, Biological treatment, Reno-Sparks Wastewater Treatment Facility, Nevada, Chemical treatment, PhoStrip process.

Stringent requirements for effluent discharged into the sensitive Truckee River ecosystem led to the use of the PhoStrip process for phosphorus removal. Originally tested at the plant during the 1970s, the original PhoStrip process is still being used in spite of a plant expansion, rather than the modified process used by many other treatment plants. After the construction was finished in 1982, the phosphorus removal process suffered startup problems: initial unreliable control system, inadvertent recycling of phosphorus-rich digested sludge from a storage lagoon, Nocardia infestations in the activated sludge, and periodic upstream discharges of toxic substances. By early 1985 the operating problems had been eliminated, and the plant began meeting its discharge requirements on a continuous basis. The operation has also become cost-effective, with potential savings of $1.3 million per year at the design flow of 40 mgd. This is a result of chemical treatment of a phosphorus-rich side stream rather than chemical treatment of the entire wastewater stream. (Cassar-PTT)
W88-05346

**FLOC FORMATION IN THE ACTIVATED SLUDGE PROCESS,**
Williamsport Sanitary Authority, PA. Wastewater Div.
M. H. Gerardi, and D. Berger.
Public Works PUWOAH, Vol. 118, No. 10, p 78-81, October 1987. 1 tab, 7 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Flocculation, Biological wastewater treatment, Bacteria, Sewage bacteria, Filamentous bacteria, Settling tanks.

Flocculation in the activated sludge process permits the separation of suspended microorganisms and their return to the aeration basin. Floc formation has three components: floc-forming bacteria, filamentous bacteria which provide the floc with a framework, and colloidal and suspended materials. The exact mechanism of floc formation is not known. However, several stages are discernable. In the lag phase of bacteria growth, organisms are freely dispersed with no floc particles present. During the log phase of growth, filamentous and floc-forming bacteria proliferate rapidly. In the declining growth phase, floc-forming bacteria begin to adhere to each other, filamentous bacteria continue to elongate, and free-swimming ciliates continue to reduce the numbers of bacteria. In the stationary or endogenous phase of bacterial growth the floc-forming bacteria adhere to the filamentous bacteria, and aggregates form from the colloidal and suspended materials, bacterial cells, mucoproteins, and polysaccharides. Nine basic types of floc can be found in the secondary clarifier: ideal (balanced growth of floc-forming and filamentous bacteria), bridged between flocs, diffused, viscous, floating, gas-entrained, curdled, pinpoint, and dispersed. Situations which promote loss of secondary solids to the effluent are rapid growth of filamentous bacteria, excessive production of slimy substances, denitrification, presence of toxic substances, and excessive shearing action. (Cassar-PTT)
W88-05347

**LOW LOAD AERATION SOLVES TREATMENT PROBLEM,**
Tracy Engineers, Inc., Camp Hill, CA.
T. Greenlund.
Public Works PUWOAH, Vol. 118, No. 10, p 80-81, October 1987. 1 tab.

Descriptors: *Wastewater treatment, *Aeration, Carlisle Suburban Authority, Pennsylvania, Cost analysis, Phosphorus removal.

The Carlisle (PA) Suburban Authority was faced with the need for rapid expansion in capacity, more stringent effluent requirements, and loss of expected EPA grant money. The counter-current low load aeration process was the answer to these problems. Diffused air is introduced through diffusers into a continuously moving mass of mixed liquor, with the mixing function being provided by the peripheral drive bridge. In the five years of operation (1982-1986) phosphorus removal in the effluent decreased from a high of 3.8 mg/liter in 1984 to 1.3 mg/liter in 1986. (Cassar-PTT)
W88-05348

**SLIPLINING FOR SEWER REHABILITATION,**
S. Gross.
Public Works PUWOAH, Vol. 118, No. 9, p 95-97, September 1987.

Descriptors: *Sewer systems, *Sliplining, *Rehabilitation, *Pipes, Polyethylene, Plastics, Linings, Sealants, Sewer infiltration, Infiltration, Utica, New York.

Sliplining, also called insertion renewal or relining, uses polyethylene pipe sections which are heat-fused into one continuous length as they are fed into the old sewer pipe. The basic steps in sliplining are as follows: (1) Clean and inspect the existing sewer line to determine if sliplining is possible. (2) Clean all debris using specialized tools. (3) In an access pit link the individual pipe lengths by fusion jointing. (4) Insert the lining by either pulling, pushing, or both. (5) Make a watertight service connection and stabilize the area around the junction with mortar mix. (6) Seal around the annular space at terminal connections. Other sliplining techniques are available. The profile-wall pipe uses a continuously extruded hollow profile spirally wound to form an outside-ribbed, smooth-inner cored pipe. This is useful in larger diameter installations. The Buttress-Loc system uses 3-ft threaded sections, installed manhole to manhole, without any digging. (Cassar-PTT)
W88-05352

**PREMIUM TREATMENT AT BUDGET PRICES,**
Clemson Univ., SC. Dept. of Environmental Systems Engineering.
L. G. Rich.
Public Works PUWOAH, Vol. 118, No. 9, p 114-115, September 1987. 2 fig, 2 tab, 9 ref.

Descriptors: *Wastewater treatment, *Filtration, *Lagoons, Sand filters, Cost analysis, Activated sludge process.

The lagoon-intermittent sand filter system provides a low-cost alternative for wastewater treatment in regions where sufficient land area is available. The lagoon system may be aerated, facultative, or a combination of the two. Effluent properties for three types of systems were compared: conventional activated sludge, complete-mix activated sludge, and lagoon-intermittent sand filter. The lagoon system compared favorably with the other systems, having similar or lower total suspended solids (14.33 mg/liter) and BOD (9.89 mg/liter). However, treatment costs for the lagoon system were about one-third of the costs for activated sludge. (Cassar-PTT)
W88-05355

**NEW APPROACH ACHIEVES INFLOW REDUCTION IN SANITARY SEWERS,**
RJN Environmental Associates, Inc., Wheaton, IL.
G. D. Lambert, and A. J. Hollenbeck.
Public Works PUWOAH, Vol. 118, No. 9, p 119-121, September 1987. 1 fig, 5 tab.

Descriptors: *Sewer infiltration, *Sewer separation, Sewer systems, Infiltration, Rehabilitation, Pipes, Illinois, Grouting.

Infiltration into sanitary sewers was studied before and after rehabilitation work in four Chicago-area communities: Des Plaines, Elk Grove Village, Winnetka, and Hoffman Estates, Illinois. These municipalities ranged in population from 13,000 to 54,000, and the length of sewer pipes from 194,000 to 658,000 ft. Actual inflow reduction ranged from 32 to 68%, very close to predicted inflow reductions, making the effectiveness level 97-114%. Public sector rehabilitation work included manhole repairs, cross connection removal, selected sewer line replacements, grouting of sewer lines, complete sewer line replacement, and sewer lining. Private sector rehabilitation included disconnection of downspouts and removal of illegal storm sump pumps and combination sump pumps from the sanitary sewer systems. (Cassar-PTT)
W88-05356

**SPECTROPHOTOMETRIC DETERMINATION OF TOTAL CYANIDE IN WASTE WATERS IN A FLOW-INJECTION SYSTEM WITH GAS-DIFFUSION SEPARATION AND PRECONCENTRATION,**
Academia Sinica, Shenyang (China). Inst. of Forestry and Soil Science.
For primary bibliographic entry see Field 5A.
W88-05357

**THERMOSPRAY LC/MS/MS ANALYSIS OF WASTEWATER FOR DISPERSE AZO DYES,**
Environmental Monitoring Systems Lab., Las Vegas, NV.
L. D. Betowski, S. M. Pyle, J. M. Ballard, and G. M. Shaul.
Biomedical and Environmental Mass Spectrometry BMSYAL, Vol. 14, No. 7, p 343-354, July 1987. 14 fig, 5 tab, 16 ref.

Descriptors: *Dyes, *Wastewater treatment, *Data acquisition, Activated sludge process, Municipal wastewater, Dye releases, Activated sludge, Effluents, Wastewater, Chromatography, Tandem mass spectrometry, Thermospray LC/MS/MS analysis, Degradation products, Degradation, Mass spectra.

Primary effluent from a municipal wastewater treatment plant was used as the feed in bench-scale activated sludge systems. These systems were spiked with disperse azo dyes at 1 milligram/liter and 5 milligrams/liter levels and were sampled at various points in the process. Samples were analyzed by high performance liquid chromatography with UV-visible detection and by thermospray ionization MS and tandem mass spectrometry (MS/MS) using direct injection or via column chromatography. The tandem mass spectrometry techniques were used both for method development purposes and for the specificity and extra information these techniques can provide. The fate of

disperse azo dyes in the activated sludge process was investigated. Major degradation products were identified by tandem mass spectrometry analyses of the wastewaters. Precision and accuracy data generated by the thermospray tandem mass spectrometry technique are compared to those derived from the high performance liquid chromatography/UV-visible method. (Author's abstract)
W88-05394

**SUSPENDED SEDIMENT AND METALS REMOVAL FROM URBAN RUNOFF BY A SMALL LAKE,**
Geological Survey, Lakewood, CO. Water Resources Div.
R. G. Striegl.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 985-996, December 1987. 10 fig, 11 tab, 21 ref.

Descriptors: *Detention reservoirs, *Urban runoff, *Water pollution sources, *Water pollution control, *Suspended sediments, *Metal removal, Runoff, Lakes, Pollutants, Metals, Water quality, Sediments, Water quality control, Chicago, Illinois, Lake sediments, Heavy metals, Copper, Iron, Lead, Zinc.

A small lake in the Chicago Metropolitan Area was from 91 to 95 percent efficient in removing suspended solids and from 76 to 94 percent efficient in removing copper, iron, lead and zinc from urban runoff. Sediments accumulated in the lake in the form of an organic-rich mud at an average rate of 20 millimeters per year; this reduced lake storage and covered potential habitat for aquatic organisms. Copper, lead, and zinc concentrations were closely associated with suspended-sediment concentrations and with silt- and clay-sized fractions of lake sediment. Although concentrations of mercury and cadmium were near detection limits in runoff, measurable concentrations of these metals accumulated in the lake sediments. (Author's abstract)
W88-05400

**AIR STRIPPING TEASES VOCS FROM GROUNDWATER,**
Hydro Group, Inc., Linden, NJ. Environmental Products Div.
F. Lenzo.
WATER/Engineering and Management WENMD2, Vol. 135, No. 2, p 27-29, February 1988. 4 ref.

Descriptors: *Aerators, *Aeration, *Groundwater pollution, *Organic compounds, *Air-stripping, *Design criteria, Operation costs, Volatility, Cost analysis, Pilot plants, Optimization.

Over the past decade, concerns about groundwater contamination have focused legislation and technology on the problem. Volatile organic compounds, (VOCs) have been identified as primary contaminants. Although no one technology is optimum for treatment in all situations, air stripping (packed tower aeration - PTA) has evolved over the past five years as the work horse technology. The contamination treated by air stripping is very common in groundwater contamination scenarios. This, along with air stripping's simplicity, efficiency, and cost effectiveness in removing VOCs has make it the preferred technology in many situations. What air stripping is and how it works is discussed, along with variables to be considered in designing pilot scale studies. (VerNooy-PTT)
W88-05429

**RECOVERY OF A MARKER STRAIN OF ESCHERICHIA COLI FROM OZONATED WATER BY MEMBRANE FILTRATION,**
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W88-05451

**MICROORGANISMS IN MUNICIPAL SOLID WASTE AND PUBLIC HEALTH IMPLICATIONS,**
Environmental Protection Agency, Cincinnati, OH. Hazardous Waste Engineering Research Lab.
For primary bibliographic entry see Field 5B.
W88-05469

**TRACE METAL INTERACTIONS WITH MICROBIAL BIOFILMS IN NATURAL AND ENGINEERED SYSTEMS,**
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
L. W. Lion, M. L. Shuler, K. M. Hsieh, and W. C. Ghiorse.
CRC Critical Reviews in Environmental Science CCECAU, Vol. 17, No. 4, p 273-306, 1988. 7 fig, 1 tab, 216 ref.

Descriptors: *Wastewater treatment, *Literature review, *Biofilms, *Metals, *Trace metals, Biological wastewater treatment, Polymers, Adsorption, Bacteria, Adsorption, Desorption, Kinetics, Particulate matter, Suspended solids, Model studies, Mathematical models, Mass transfer, Chelation, Organic matter, Detoxification.

Trace metal adsorption and desorption are important processes in natural aquatic systems and in designed treatment systems. Several surfaces are present for metal binding: bacterial cells surfaces, extracellular polymers produced by the bacteria, and inorganic surfaces. Adsorption of metals onto particulate matter and humic substances has been documented in fresh water and marine systems. Microorganisms (bacteria, fungi, protozoa, and algae) have great propensity for attaching to surfaces. Examples are biofilms in water systems and floc formation. Formation of exopolysaccharides by bacteria varies with the culture and growth conditions. Conditions associated with high rates of polymer formation are phosphorus or nitrogen limitation, growth phase (varies with culture), oxygen stress, and presence of metal ions. Although biofilms coating surfaces are well documented, the chemical mechanisms concerning metal removal have not been investigated thoroughly. Biofilms consist predominantly of bacterial cells enmeshed in a network of negatively charged extracellular polymers. The biofilms are assumed to contain ferromanganese deposits which can play an important role in trace metal absorption. Microorganisms have developed resistance to metal toxicity, especially since the Industrial Revolution. Detoxification mechanisms include biomethylation, biosynthesis of intracellular traps, cellular efflux, synthesis of chelating agents, and surface precipitation. Mathematical models have been developed to describe various aspects of trace metal interaction with surfaces: (1) cellular growth, attachment, and polymer production; (2) metal binding to inorganic surfaces; (3) metal binding to cellular surfaces; (4) biofilm model integrated with a metal-binding model. Types of bench-scale reactors used to study biofilms are columns, annular reactors, rotating biological contactors, and flow-by reactors. (Cassar-PTT)
W88-05470

**BILLION DOLLAR BABY: 100 PCS WATCH OVER TREATMENT PLANT,**
Municipality of Metropolitan Seattle, WA.
For primary bibliographic entry see Field 5F.
W88-05472

**SEWERS GET A BREATH OF FRESH AIR,**
Diversified Engineering Services, Inc., New Orleans, LA.
J. C. Wernicke.
Civil Engineering CEWRA9, Vol. 57, No. 8, p 67-69, August 1987. 2 fig.

Descriptors: *Wastewater treatment, *Sewer systems, *Odor control, *Oxygenation, Sewer gas, Hydrogen sulfide, Anaerobic conditions.

Hydrogen sulfide is a source of odor and corrosion in wastewater treatment facilities. When oxygen in wastewater becomes depleted by bacterial action, bacterial conversion of sulfates to hydrogen sulfide takes place. Sulfide production can be prevented by high flow velocities which aerate the wastewater. In force mains oxygen must be added. Costs are generally $25,000 to $200,000. A typical oxygen injection station consists of storage tank, vaporizer, controls, and injection system. An additional advantage of oxygenation is reduction in organic loading in the downstream treatment plant. Cryogenic oxygen tanks are available from 500 to 13,000 gal. Larger volumes require on-site production systems. The average consumption of oxygen is 2-4 pounds per pound of sulfur. Maximum oxygen dissolving occurs where the fluid is turbulent and at high injection pressures; this should be considered in planning the site of injection and number of injection sites. There are two types of oxygen injectors. One is based on direct injection against the pump discharge pressure. The other uses a sidestream injection that removes 25% of the main flow, pressurizes it to 100 psi and then injects the oxygen before the sidestream is returned to the main flow. (Cassar-PTT)
W88-05479

**SEWER-SEPTIC TANK HYBRID PROMISES SAVINGS,**
Ayres Associates, Madison, WI.
R. J. Otis, and K. Sirotiak.
Civil Engineering CEWRA9, Vol. 57, No. 8, p 74-78, August 1987. 3 fig.

Descriptors: *Wastewater treatment, *Septic tanks, *Sewer systems, Drains, Cost analysis.

The Septic Tank Effluent Drain system was used to solve the problem of above-ground septic effluent drainage in Westboro, Wisconsin. In this design each house retains its septic tank, and the solids-free effluent from the tank is carried away by a small-diameter gravity sewer. Maintenance involves pumping the septic tanks every three years. Drain cleaning has not been necessary because any slime formation is removed during heavier flows. Minor problems have been infiltration of grit and dirt through manholes and rainwater/snowmelt through cracked septic tank covers. Similar installations were made for 31 low-income homes in Mt. Andrew, Alabama, for homes in Maysville, Ohio. This system offers several advantages by reducing (1) excavation, (2) materials needs, (3) maintenance requirements, (4) infiltration/inflow, (5) water requirements. (Cassar-PTT)
W88-05480

**DIGESTER DO-OVER,**
Kennedy/Jenks/Chilton, Inc., Federal Way, WA.
R. C. Guglomo, and M. Larsen.
Civil Engineering CEWRA9, Vol. 57, No. 12, p 48-49, December 1987. 1 fig.

Descriptors: *Wastewater treatment, *Digestion, *Odor control, *Rehabilitation, Anaerobic digestion, Corrosion, Cracks, Concrete, Orange County, California.

Six digesters in Orange County, California, are being rehabilitated at the cost of $5 million instead of being replaced for $18 million. These structures, at the end of their service lives, were badly cracked by seaspray and internal acid corrosion and temperature variations. In addition, odors were offending the surrounding community. Immediate repairs to the concrete domes included sand- and waterblasting of spalling concrete and repair of cracks by epoxy injection or polymer grouting for the hairline cracks and larger cracks, respectively. Next, the longer-range rehabilitation was started. A PVC liner was attached to the inside to prevent deterioration above the water level. An insulating barrier was added to the exterior dome to reduce the temperature differences and to lower winter heating requirements. This consisted of 2-in thick polyurethane foam and a polyurethane roof coating. The steel dome required raising the dome, adding 36 supports to allow movement during wind loads, sealing the annular space between the dome and wall, and packing oakum into empty space. New recirculation systems were installed to prevent scum build-up. (Cassar-PTT)
W88-05482

**SEWAGE PLANT ENGINEERED FOR VALUE,**

O'Brien-Kreitzberg and Associates, Inc., Merchantsville, NJ.
W. F. Mikes.
Civil Engineering CEWRA9, Vol. 58, No. 1, p 50-52, January 1988.

Descriptors: *Wastewater treatment, *Value engineering, *Sewer systems, Camden County Municipal Utilities Authority, New Jersey, Engineering, Cost analysis, Biological wastewater treatment.

Value engineering resulted in savings of $52.5 million in capital costs in a sewage system originally estimated to cost $600 million. Thirty-seven small towns joined to form the Camden County Municipal Utilities Authority to combine wastewater handling functions. For this project some of the original designs were rated most cost effective. For the sludge handling system it was recommended that the proposed building be eliminated and the thickener tanks be enclosed with fiberglass domes, retaining a small structure for pumps and blending tank. Substitution of continuous conveyors for on-site trucking was another large cost saving. The design specified demolition of the services building. Value engineering proposed that the building be retained with addition of a new administrative wing. Construction management was also organized for cost savings of $1.8 million. (Cassar-PTT)
W88-05486

**METAL TOXICITY ON PHOSPHATE REMOVAL IN PURE CULTURE AND IN ACTIVATED SLUDGE SYSTEMS,**
Maryland Univ., College Park. Dept. of Civil Engineering.
O. J. Hao, and C. H. Chang.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 38-53, February 1988. 11 fig, 39 ref. NSF Grant CEE-8306814.

Descriptors: *Phosphorus removal, *Activated sludge process, *Wastewater treatment, *Bioindicators, *Pollutant identification, Bacteria, Acinobacter, Phosphates, Phosphorus compounds, Biological wastewater treatment, Activated sludge, Toxicity, Zinc, Heavy metals, Enzymes, Growth.

Environmental factors, operational conditions, and wastewater characteristics may affect organic substrate utilization. Thus, these factors must be considered for successful biological phosphate removal from wastewater. Metal toxicity on phosphate removal in chemostat studies of Acinobacter species, in batch activated sludge, and sequencing batch systems was investigated. At a Zn(II) concentration of 10 milligrams/liter (mg/L), phosphorus content in cell mass was reduced from 3.2-4.8% of the control system to 2.0-2.8%, depending on the dilution rate in Acinobacter continuous culture studies. In a batch activated sludge system, 20 mg/L Zn reduced phosphorus uptake from 23-16 mg/L. In a sequencing batch system, addition of 10 mg/L Zn inhibited phosphate removal after 14 days of continuous Zn addition. In all cases, COD utilization was not affected. Thus, in comparison with oxidative enzymes, the enzymes responsible for the formation of polyphosphate granules are more sensitive to Zn toxicity. Since they exhibit high phosphate uptake during the log-growth stage, the use of Acinobacter species to detect compound toxicity on phosphate uptake is recommended. (Wood-PTT)
W88-05509

**RULE-BASED MODEL OF DESIGN JUDGMENT ABOUT SLUDGE BULKING,**
Kereomel Environmental Systems Analysts, Champaign, IL
J. J. Geselbracht, E. D. Brill, and J. T. Pfeffer.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 54-73, February 1988. 4 fig, 10 tab, 20 ref. University of Illinois at Urbana-Champaign Grant S-092-ILL.

Descriptors: *Artificial intelligencee, *Bulking sludge, *Wastewater treatment, *Rule-based models, *Model studies, Wastewater facilities, Design criteria, Activated sludge process, Activated sludge, Economic aspects, Sludge, Model testing, Judgement.

The use of a rule-based approximate reasoning modeling technique is illustrated in the context of wastewater treatment plant design. Sludge bulking is a poorly understood problem in activated sludge wastewater treatment plants. An engineer must use his judgment gained from experience to design a plant to prevent bulking and the attendant failure. An attempt was made to use fuzzy logic to model that judgment. Results from the literature were formulated in a rule-based model that relates design variable values to the likelihood of a design experiencing bulking problems. The model was calibrated and checked for consistency against an experienced engineer's evaluation of two sets of 15 plant designs. The model of judgment could be used to evaluate the bulking potential of any design. The model was also incorporated into a plant design optimization method of bulking was examined for a typical problem. (Author's abstract)
W88-05510

**MORE ON MECHANISM AND SOME IMPORTANT PROPERTIES OF CHROMATE ION EXCHANGE,**
Lehigh Univ., Bethlehem, PA. Dept. of Civil Engineering.
A. K. Sengupta, S. Subramonian, and D. Clifford.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 137-153, February 1988. 8 fig, 1 tab, 19 ref, append.

Descriptors: *Chromate ions, *Waste recovery, *Anion exchange, *Chemical reactions, Hydrogen ion concentration, Ion exchange, Dimerization, Resins, Ions, Anions, Kinetics, Mathematical equations, Chromium compounds.

Sufficient experimental data are presented to verify the chromate ion-exchange mechanism proposed earlier. Most of the experiments were tailored to prove the validity of the mechanism, and also to highlight the unusual effects associated with it. One significant finding of this study is that, in spite of very gradual breakthrough during fixed-bed column runs, chromate(VI) concentration at the exit of the column remains almost independent of the influent Cr(VI) concentration for a long time after the start of the run. Mass-transfer limited kinetics are not responsible for this conspicuous column characteristic. Such an anomalous behavior is explained with the proposed ion-exchange mechanism, which suggests dimerization of HCrO4(-) into Cr2O7(2-) inside the commercial organic-base anion-exchange resins. A more theoretically sound attempt can now be developed for designing fixed bed chromate-exchange processes at acidic pH in the presence of other competing ions. (Author's abstract)
W88-05515

**NITROGEN CONTROL OF COMPLEX INDUSTRIAL WASTEWATERS,**
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
H. Melcer, and S. G. Nutt.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 166-178, February 1988. 2 fig, 3 tab, 18 ref.

Descriptors: *Nitrogen removal, *Biological wastewater treatment, *Industrial wastewater, *Wastewater treatment, Coal-processing wastes, Fluidized bed process, Denitrification, Anaerobic digestion, Biodegradation, Solvent extraction, Nitrification.

A coupled biological fluidized bed system, operated in the pre-denitrification mode, was used to evaluate its potential in implementing nitrogen removal from raw and diluted coking plant wastewaters and coal liquifaction condensates. The latter wastewater was also subjected to pretreatment by solvent extraction with light oil, methyl isobutyl ketone and 2-octanone, and anaerobic degradation to evaluate the improvement in nitrification. Complete nitrification and denitrification was achieved for raw and diluted coking plant wastewater and for diluted and solvent extracted coal liquefaction condensates. Maximum specific nitrification rates increased with increasing dilution. Increased intensity of pretreatment led to stable nitrification at lower dilutions. Anaerobic pretreatment offered a possible alternative to solvent extraction. A complex tradeoff exists between the intensity of pretreatment, the degree of dilution and the size of the downstream biological treatment system. (Author's abstract)
W88-05517

**HYDRAULICS OF HORSESHOE AND ARCH SEWERS,**
Detroit Water and Sewerage Dept., MI.
For primary bibliographic entry see Field 8B.
W88-05518

**MIXING INTENSITY AND POLYMER PERFORMANCE IN SLUDGE DEWATERING,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
J. T. Novak, J. F. Prendeville, and J. H. Sherrard.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 190-198, February 1988. 10 fig, 7 ref.

Descriptors: *Sludge drying, *Polymers, *Particles, *Dewatering, *Wastewater treatment, *Sludge conditioning, Activated sludge, Alum sludge, Wastewater, Mixing, Drying, Model studies, Sludge.

A laboratory study was conducted to determine if the best polymer for sludge conditioning at one mixing intensity (G) is the best polymer under all mixing conditions (Gt). An activated and an alum sludge were conditioned with a variety of polymers at several polymer concentrations. Effectiveness of conditioning is measured by a capillary suction time device. Based on the experimental results, it is concluded that alum and activated sludges can be conditioned to resist deterioration resulting from intense mixing and can be dewatered efficiently using high stress mechanical dewatering processes, that polymer requirements increase as Gt increases for both alum and activated sludge, that polymer selection is more important at high mixing energy inputs than at low energy inputs, and that the activated sludge tested appears to be resistant to the effects of polymer overdosing. From an analysis of these results and other data reported in the literature, a mechanistic model is described polymer-particle interaction is proposed. (Author's abstract)
W88-05519

**EFFECTS OF SMP ON BIOFILM-REACTOR PERFORMANCE,**
Procter and Gamble Co., Cincinnati, OH. Ivorydale Technical Center.
E. Namkung, and B. E. Rittmann.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 199-210, February 1988. 5 fig, 1 tab, 15 ref. USEPA Cooperative Agreement CR 810462.

Descriptors: *Wastewater treatment, *Soluble microbial products, *Biofilm reactors, *Biological wastewater treatment, *Advanced wastewater treatment, *Water treatment, Drinking water, Groundwater recharge, Model studies, Organic carbon, Effluents.

The extended steady state biofilm model is utilized to predict the performance of a completely mixed biofilm reactor in terms of substrate removal, biofilm accumulation, soluble microbial products (SMP) formation, and total soluble organic carbon (SOC) removal. Three important aspects of how SMP formation affects the effluent quality from biofilm reactors for the concentration range of practical interest are relevant to advanced wastewater treatment, groundwater recharge, and drinking water treatment. First, for intermediate surface loadings, the concentrations of the effluent SMP and SOC are directly proportional to the influent substrate concentration, and SMP comprises the majority of effluent SOC. However, for high and very low loading, residual substrate is most of the effluent SOC. Second, SMP formation and SOC removal by the steady state biofilms are affected by both substrate utilization kinetics and

reactor conditions. Changing reactor conditions, such as hydraulic detention time, affect the actual surface loading, while kinetic parameters, such as biofilm loss rate and cell yield, control the minimum achievable substrate concentration and the minimum flux to give a deep biofilm. Third, in order to achieve the best treatment efficiency in terms of organic carbon, the biofilm reactor must maintain an optimum biofilm thickness that gives the lowest SOC concentration. At least in concept, biofilm thickness can be controlled by manipulating the shear loss component of the biofilm loss rate. (Author's abstract)
W88-05520

**NEW APPROACH FOR SIZING RAPID INFILTRATION SYSTEMS,**
Cold Regions Research and Engineering Lab., Hanover, NH.
J. M. Martel.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 211-215, February 1988. 1 fig, 2 tab, 13 ref.

Descriptors: *Rapid infiltration, *Site sizing, *Wastewater treatment, *Land disposal, *Infiltration, Soil filters, Wastewater, Batch treatment, Mathematical equations, Intake capacity, Drinking water, Land use, Land application.

Rapid infiltration (RI), a wastewater treatment method that uses the natural renovative powers of the soil matrix to remove pollutants, can produce a percolate of drinking-water quality if the system is designed and operated efficiently. The current EPA procedure for calculating the land area required by a RI system is based on the limiting infiltration rate at the proposed site which is difficult to measure because it varies from place to place on the site. A new, less complex approach to sizing RI systems based on the observation that most RI systems operate as a batch process is presented. The long-term intake capacity per cycle is the critical design parameter needed in this approach. Analysis of data from eight operational systems indicate that the intake capacity is mainly a function of the application time. (Wood-PTT)
W88-05521

**CRITICAL LOOK AT ROCK FILTERS,**
Clemson Univ., SC. Dept. of Environmental Systems Engineering.
L. G. Rich.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 219-223, February 1988. 2 fig, 1 tab, 13 ref.

Descriptors: *Rock filters, *Algal control, *Wastewater treatment, *Wastewater lagoons, *Service life, Wastewater, Rocks, Lagoons, Effluents, Algae, Sedimentation, Flotation, Interception, Microbial degradation, Economic aspects, Feasibility, Mathematical equations.

Rock filters, which have been used for more than a decade to remove algal cells from the effluents of sewage lagoons, consist of submerged rock beds through which lagoon effluent flows. The rock media is composed of 5- to 20-centimeter rocks with void spaces comprising 40-45% of the total volume. Algal solids removed by the filter by a combination of sedimentation, flotation, and interception undergo microbial degradation, leaving the refractory components to accumulate in the voids. The service life of rock filters was estimated based on an equation describing the voids depletion time which is a function of the solids removal rate, which in turn, is a function of the volumetric loading rate on the rock filter. Simple mass balance considerations using realistic assumptions concerning biodegradable fractions and sludge solids-moisture compositions revealed the limited service life of this type of filter. Because failure can be expected earlier than was previously predicted, and because of the cost of replacement, rock filters are not the viable option for effluent polishing that they were previously thought to be. (Wood-PTT)
W88-05522

**REMOVAL OF TOXIC MATERIALS FROM IN SITU TAR SAND PROCESS WATER,**
Oklahoma State Univ., Stillwater. School of Civil Engineering.
W. F. McTernan, P. H. King, and W. E. Blanton.
Journal of Energy Engineering (ASCE) JFEED9, Vol. 113, No. 3, p 79-91, December 1987. 4 fig, 9 tab, 19 ref. DOE Contract DE-AS20-81LC10678.

Descriptors: *Tar sand extraction, *Toxic materials, *Wastewater treatment, *Process water, *Industrial wastewater, Industrial wastes, Vernal Utah, Bitumen, Toxicity, Coagulation, Organic carbon, Suspended solids, Activated carbon, Pollutant identification, Pollutants.

Process waters collected during a Department of Energy in situ tar sand extraction experiment near Vernal, Utah, were characterized as having a high level of emulsified bitumen, exhibiting toxic properties and possessing low levels of inorganic constituents. Various coagulants were employed in an attempt to destabilize this emulsion. Ferric chloride was found to be most effective in that more than 98% of the emulsion was removed as total organic carbon (TOC) by this treatment and over 99% was removed as suspended solids. Increased toxicity levels were measured, however, in these treated effluents. Additional treatment by activated carbon adsorption removed these toxic components. Gas chromatography/mass spectrometry (GC/MS) analysis, using a modification of the U.S. Environmental Protection Agency (EPA) method 625, showed an estimated 2,000 compounds in the untreated process water. Coagulation reduced this to 72 identifiable components while activated carbon adsorption lowered this to six, including internal and recovery standards. GC/MS was unable, however, to identify a relatively significant series of materials shown to exist by TOC analysis which apparently had low vapor pressure and could not be analyzed by gas chromatography. The source or sources of the residual toxicity is assumed to be contained in these unidentified materials. (Author's abstract)
W88-05523

**SITING MODEL FOR REGIONAL WASTEWATER TREATMENT SYSTEMS: THE CHAIN CONFIGURATION CASE,**
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
Z. Zhu, and C. ReVelle.
Water Resources Research WRERAO, Vol. 24, No. 1, p 137-144, January 1988. 3 fig, 5 tab, 30 ref.

Descriptors: *Wastewater facilities, *Site selection, *Systems analysis, *Project planning, Sites, Planning, Wastewater treatment, Model studies, Mathematical studies, Mathematical equations, Mathematical models, Economic aspects, Linear programming, Water quality, Costs.

The techniques of locations systems analysis are adapted to develop a siting model for wastewater treatment facilities when the wastewater sources and treatment facilities are in a chain or linear configuration. The regional facility problem is considered as a special variant of the fixed charge plant location model rather than the general transshipment type model. The definition of the additional cost of a waste source joining a regional facility and the development of sequential priority constraints in the siting model allow the siting model to be conveniently solved by widely available linear programming packages. The model deals with the situation in which no current treatment is provided, no bypassed plants are allowed, a fixed level of treatment is required, and water quality constraints are either not included or are not binding. The concave cost of treatment at a plant is approximated by a fixed charge and one straight-line segment. Numerical examples are included to demonstrate the computational efficiency of the siting model. (Author's abstract)
W88-05538

**MODELING DYNAMIC EXPERIMENTS ON THE ANAEROBIC DEGRADATION OF MOLASSES WASTEWATER,**
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Dept. of Chemical Engineering.
M. Denac, A. Miguel, and I. J. Dunn.
Biotechnology and Bioengineering BIBIAU, Vol. 31, No. 1, p 1-10, January 1988. 17 fig, 5 tab, 24 ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Anaerobic digestion, *Molasses, *Organic acids, Sugars, Food-processing wastes, Biodegradation, Packed beds, Kinetics, Degradation, Hydrogen gas effects, Hydrogen ion concentration, Hydrogen, Model studies, Model testing, Simulation, Methane.

The kinetics of anaerobic degradation of a molasses wastewater were measured under constant pH conditions in a laboratory scale packed bed reactor. In continuous and batch experiments the formation and degradation rates of the organic acids (butyric, propionic and acetic) were followed. The influence of hydrogen gas on the acid degradation rates was measured and, contrary to the literature and the thermodynamic calculations, no inhibition was detected; biofilm diffusional effects may be the reason. Two dynamic simulation models were tested, a heterogeneous model, which considered the biofilm-reaction phenomena and a quasihomogeneous model with the same kinetics. Except for hydrogen, the diffusion effects were negligible. Otherwise both models gave essentially the same results and the time profiles of acids, hydrogen, carbon dioxide and methane agreed relatively well with dynamic startup experiments. Batch experiments showed the acid concentrations to be highly sensitive to the initial molasses concentration. This aspect was not included in the model but is being investigated further. (Author's abstract)
W88-05547

**ALUM FLOCCULATION AND BIOFLOCCULATION OF ACTIVATED SLUDGE FOR VACUUM FILTRATION,**
Missouri Univ.-Columbia. Dept. of Civil Engineering.
R. A. Novak.
Biotechnology and Bioengineering BIBIAU, Vol. 31, No. 1, p 71-74, January 1988. 4 fig, 17 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Flocculation, *Filtration, Nitrogen, Chemical oxygen demand, Activated sludge, Alum, Bioflocculation, Biological wastewater treatment, Sludge, Load distribution, Carbohydrates, Proteins, Cost analysis.

The nature of a particular activated sludge determines the optimum dosage of chemical coagulant and the overall effectiveness of chemical conditioning. The properties of the individual sludge are, in turn, controlled by operating conditions in the aeration tank and the characteristics of the influent waste. The relationships between sludge loading rate, COD-to-nitrogen ratio of influent waste and maximum difference in specific resistance as a result of chemical conditioning (deltaZ) were investigated. The maximum difference in specific resistance was found to be highly dependent on COD/N. The parameter deltaZ was related to sludge carbohydrate content, protein content, and surface charge in the same manner as specific resistance. Circumstances under which chemical conditioning is ineffective and not cost efficient were explored. It was found that deltaZ is minimal when an activated sludge exhibits a high degree of biological flocculation. Under carbon-limiting growth and optimal loading conditions, deltaZ was low enough to make chemical conditioning unnecessary. (Wood-PTT)
W88-05548

**ANAEROBIC DEGRADATION OF PAPERMILL SLUDGE IN A TWO-PHASE DIGESTER CONTAINING RUMEN MICROORGANISMS AND COLONIZED POLYURETHANE FOAM,**
Katholieke Univ. Nijmegen (Netherlands). Dept. of Microbiology.
H. J. Gijzen, T. J. M. Schoenmakers, C. G. M. Caerteling, and G. D. Vogels.
Biotechnology Letters BILED3, Vol. 10, No. 1, p 61-66, January 1988. 4 fig, 1 tab, 13 ref.

Descriptors: *Wastewater treatment, *Industrial wastewater, *Substrates, *Sludge digestion, *Poly-

urethane, Bacterial physiology, Anaerobic digestion, Biodegradation, Microorganisms, Protozoa, Volatile acids, Fatty acids, Methane.

The catabolism of volatile fatty acids and methane formation are rate-limiting steps in the anaerobic digestion of soluble wastes because of the low growth rates of the bacteria involved. Thus, long retention times are required to prevent washout of the active biomass. In this study, methanogenic associations were immobilized on 2.2-cm cubes of polyurethane foam in a 10-l continuous upflow reactor fed on a mixture of acetate, propionate, and butyrate and maintained at 39 C for 3 weeks. Bacterial colonization was rapid and dense. The support particles were then transferred to a two-phase reactor, the 5-l first phase of which had been inoculated with sheep rumen microorganisms. In a 60-day experiment, biogas production was stable at about 330 l/d after the 5th day. Methane amounted to about 55% of the biogas. Concentrations of individual volatile fatty acids showed some fluctuations (most explicit for propionate) but stabilized from day 35 on. The study demonstrates that polyurethane may be used as an excellent support material for slowly-growing methanogenic-phase bacteria. The combination of rumen microorganisms in the acidogenic phase and colonized support particles in the methanogenic phase of a two-phase reactor resulted in efficient anaerobic digestion of papermill sludge. (Shidler-PTT)
W88-05559

**DON'T BOTHER WITH SECONDARY CLARIFIER DISTRIBUTED INLETS,**
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
J.H. Bender, J.A. Semon, and R.M. Crosby.
Water Engineering and Management WENMD2, vol. 134, no. 12, p 2830, December 1987, 1 fig, 2 tab, 5 ref. EPA Cooperative Agreement CR810261.

Descriptors: *Distributed inlet, *Wastewater treatment, *Clarifiers, *Activated sludge process, Municipal wastewater, Municipal wastes, *Clarifiers, Wastewater facilities, Desnity currents, Uniform flow.

At the Stamford, Connecticut, Water Pollution Control Facility for activated sludge wastewater treatment, the EPA Water Engineering Reasearch Laboratory evaluated an inlet structure called the distributed inlet. This inlet was designed to create a uniformly distributed flow pattern in one of the secondary clarifiers. While the inlet created a fairly uniform flow in the immediate vacinity, it could not sustain this pattern across the clarifier's full area. Performance was also degraded. Results from this project and earlier test work indicate that inlet structures have little influence on the avoidance of density current formation. This prevents them from creating a uniformly distributed flow throughout the entire clarifier. Inlet structure design, however, still remains an important aspect of clarifier design, although its role in creating a uniformly distributed flow pattern is disputed. (Sand-PTT)
W88-05564

**BUILDING AN EFFECTIVE COMPUTER MAPPING PROGRAM,**
Metropolitan Sewer District of Greater Cincinnati, OH. Div. of Wastewater Engineering.
H. E. Perkins and, and T. Armbruster.
Water/Engineering and Management WENMD2, Vol. 134, No. 8, p 21-24, August 1987.

Descriptors: *Digital Computers, *Subsurface Mapping, *Sewer Systems, *Automation, Wastewater Management, Sewer Districts.

A sanitary sewer district can effectively maintain approximately 7,000 maps of sewered areas, update and create wastewater collection system maps, and increase productivity by using computers in the process of mapping. Constantly changing information is now more difficult than ever to collect, organize, record and retrieve as it accumulates. The Metropolitan Sewer District of Greater Cincinnati (MSD) began investigating digital data base mapping options and funding sources in 1976. Now the District has more than 1,500 base maps in a digital format, a portion of the budget dedicated to computer mapping, an expanded in-house computer system and new opportunities for sharing the benefits of the mapping program with neighboring agencies. Numerous benefits from digitizing information are listed and discussed. (VerNooy-PTT)
W88-05565

**HOW WASTEWATER TREATMENT PLANTS UTILIZE DIGESTER GAS,**
Brown and Caldwell, Pleasant Hill, CA.
For primary bibliographic entry see Field 5E.
W88-05567

**USING OXYGEN TO CONTROL HYDROGEN SULFIDE IN MUNICIPAL WASTEWATER SYSTEMS,**
BOC Group, Inc., Murray Hill, NJ. Airco Industrial Gases Div.
G. H. Hollerbach.
Water/Engineering and Management WENMD2, Vol. 134, No. 8, p 46-49, August 1987. 2 fig, 8 ref.

Descriptors: *Dissolved oxygen, *Wastewater treatment, *Oxygen injection, *Hydrogen sulfide, *Oxygen injection, *Anaerobic conditions, Main sewers, Bubbles, Cost analysis, Australia, United Kingdom, United States.

Two major methods commonly used to control hydrogen sulfide are oxygen augmentation and the chemical application of various oxidants, toxic substances or metallic salts. A successful and cost effective method of controlling H2S generation is to inject high purity oxygen into the wastewater flowing in the force main, thus increasing the dissolved oxygen content of the sewage. An Australian community has been practicing this method for ten years. Direct oxygen injection techniques were developed in the United Kingdom by BOC Ltd. in collaboration with the Water Research Centre. Pure oxygen injection is highly effective in preventing anaerobic conditions and the consequent generation of sulfides. Since 1973, more than 100 installations have been completed in the U.K. and Australia. In the U.S., direct oxygen injection has gained acceptance and has proved to be an effective solution to sulfide generation in force mains with irregular profiles. There is no one best oxygen injection system for either pressure mains or gravity mains. Each wastewater collection system is different and requires an oxygen injection system designed for the most effective control of H2S under local conditions. (VerNooy-PTT)
W88-05568

**ACTIVATED SLUDGE TREATMENT OF WINE-DISTILLERY WASTEWATERS,**
Cadiz Univ. (Spain). Faculty of Sciences.
D. Sales, M. J. Valcarcel, L. Perez, and E. Martinez-Ossa.
Journal of Chemical Technology and Biotechnology JCTBDC. Vol. 40, No. 2, p 85-99, 1987. 5 fig, 5 tab, 11 ref.

Descriptors: *Wastewater treatment, *Distillery wastes, *Activated sludge treatment, *Neutralization, *Aerobic digestion, Purification kinetics, Vinasses, Biological oxygen demand, Hydrogen ion concentration, Mathematical models, Optimization, Chemical oxygen demand.

Wine alcohol distilleries produce eight volumes of high-strength waste from every volume of ethanol. This waste has an acidic character, an average COD of 21 g/cu dm and an average BOD of 13 g dm to the minus 3rd power. This paper examines aerobic treatment as an alternative to anaerobic digestion for the reduction of waste strength. The process from the startup of the digesters until attainment of steady-state conditions, and the optimization of the process to achieve an adequate purifying performance, were studied. Once optimum operation conditions had been attained (at 8 days retention time), the effluent showed: pH values between 6.5 and 8; COD and BOD removals of 78 and 88%, respectively; dissolved oxygen contents of over 1 mg/cu dm; and microorganism populations of over 1 billion colonies/cm. Neutralization of vinasses did not improve the purification process. A Substrate Utilization Model predicted accurately the performance of the purifying process, except at retention times of less than 3 days, where the system works in unsteady conditions. (Author's abstract)
W88-05572

**ANAEROBIC DIGESTION OF SURPLUS ACTIVATED SLUDGE IN A FIXED-FILM BIOREACTOR,**
Genoa Univ. (Italy). Ist. di Scienze e Tecnologie dell'Ingegneria Chemica.
C. Solisio, and M. Del Borghi.
Water Research WATRAG, Vol. 21, No. 11, p 1301-1305, November 1987. 7 fig, 7 tab, 6 ref.

Descriptors: *Anaerobic digestion, *Activated sludge, *Wastewater treatment, *Fixed-film bioreactors, Biological treatment, Sludge, Biological treatment, Organic loading, Waste load, Biological oxygen demand, Chemical oxygen demand, Volatile solids.

The performance of a particular fixed-film bioreactor with sponges as support was evaluated and compared with that of a conventional continuous stirred tank reactor (CSTR). The fixed-film digester performed better than the conventional CSTR, particularly at low organic loads. Good results were similarly obtained with the fixed-film digester at high organic loads and for biogas production. In all cases, the fixed-film digester removed greater amounts of volatile solids, biological oxygen demand, and chemical oxygen demand. The synthetic sponges employed as support for microorganism growth in place of the usual rocks or other rigid materials allowed satisfactory microorganism trapping as well as easy regeneration. (Wood-PTT)
W88-05584

**ACTIVITIES OF SOME FERMENTATION ENZYMES IN ACTIVATED SLUDGE AND THEIR RELATIONSHIP TO ENHANCED PHOSPHORUS REMOVAL,**
Johannesburg City Health Dept. Labs. (South Africa).
L. H. Lotter, and E. H. M. van der Merwe.
Water Research WATRAG, Vol. 21, No. 11, p 1307-1310, November 1987. 6 fig, 2 tab, 23 ref.

Descriptors: *Enzymes, *Activated sludge, *Phosphorus removal, *Wastewater treatment, *Fermentation, *Monitoring, Enzyme activities, Dehydrogenase, Phosphorus, Sludge, Biological wastewater treatment.

A method to determine lactate, malate, beta-HO-butyrate dehydrogenase and phosphotransacetylase activities in activated sludge was developed. The method was used to monitor two of the enzymes, which showed correlation with phosphorus removal in two activated sludge plants. The phosphorus removal capacity of the two plants showed different sensitivities to changes in the activities of beta-HO-butyrate dehydrogenase and phosphotransacetylase. (Author's abstract)
W88-05585

**BOUND WATER CONTENT OF BIOLOGICAL SLUDGES IN RELATION TO FILTRATION AND DEWATERING,**
Athens School of Hygiene (Greece).
N. Katsiris, and A. Kouzeli-Katsiri.
Water Research WATRAG, Vol. 21, No. 11, p 1319-1327, November 1987. 8 fig, 5 tab, 37 ref.

Descriptors: *Bound water, *Sludge drying, *Sludge filtration, *Wastewater treatment, *Differential thermal analysis, Sludge, Dewatering, Drying, Coagulation, Chemical coagulation.

The results are presented of an extensive analytical investigation on the mechanisms involved in filtration of biological sludges obtained by studying the changes in the bound water content of activated and mixed digested sludges when they were subjected to several physical and chemical processes.

Water in sludges exists in two states, as free or bulk water and as bound water which is held by the solid state either by sorption on specific sites, i.e. functional groups of the proteins and other macromolecules and/or restricted within pores and capillaries. A new method for determining bound water in sludges, based on differential thermal analysis (DTA), was developed. The technique is based on the same assumption that was used in previous studies that bound water does not freeze when the sample is cooled down to -20 degrees C. The temperature difference between the sample and a thermally inert material was recorded when the two specimens were subjected to identical temperature regimes involving heating or cooling at a controlled rate. A low cooling rate of 2 deg C/min and a high sensitivity setting were chosen to permit possible differentiation between bulk and bound water in the thermograms. Values of the bound water measured by DTA were compared to those obtained using a dilatometer; for an activated sludge sample with 0.4% dry solids, the values of bound water obtained by DTA and the dilatometer were 1068 and 1140%, respectively. Given the difficulties in measuring bound water by the dilatometric technique, the faster, more reliable DTA method was adopted for the experiments. All chemical coagulants, including FeCl3, AlCl3, and FeSO4, and cationic polyelectrolytes resulted in a reduction of the specific resistance and the bound water content of the sludge which was due to the replacement of water molecules by the adsorbed coagulant. Heat treatment of activated and digested sludge at 130 degrees C resulted in a reduction of bound water by 30% whereas freezing and thawing reduced bound water by 70%. (Wood-PTT)
W88-05587

**BEHAVIOUR OF AN ANAEROBIC EXPANDED BED REACTOR IN NON-STEADY STATE CONDITIONS,**
Valladolid Univ. (Spain). Dept. of Chemical Engineering.
P. A. Garcia Encina, and F. Fernandez-Polanco.
Water Research WATRAG, Vol. 21, No. 11, p 1329-1334, November 1987. 9 fig, 2 tab, 13 ref. CAICYT Project 37-82.

Descriptors: *Expanded bed reactors, *Wastewater treatment, *Biological wastewater treatment, *Anaerobic digestion, Food-processing wastes, Industrial wastes, Organic loading, Waste load, Volatile acids, Effluents, Temperature effects.

A series of experiments was conducted on an expanded bed anaerobic reactor operating at high organic loading rates in non-steady state conditions such as those found during start-up periods, after shut-down, or during periods of strong fluctuation in operating variables. Because volatile fatty acids (VFA) are intermediate products in the anaerobic degradation process, the variation of their concentrations in the effluent was measured. Wastewater from a beet sugar factory was used for the experiments conducted during start-up, after shut-down, and during fluctuations caused by increasing organic loading rates, temperature variations, and air inflow variation. In all cases, the reactor demonstrated great stability with short recovery periods. The start-up was rapid enough to compensate for seasonal or weekend shut-downs. (Wood-PTT)
W88-05588

**HEAVY METAL REMOVAL FROM WASTE WATER FROM WET LIME(STONE)-GYPSUM FLUE GAS DESULFURIZATION PLANTS,**
Keuring van Electrotechnische Materialen N.V., Arnhem (Netherlands).
J. B. Lefers, W. F. van den Broeke, H. W. Venderbosch, J. de Niet, and A. Kettlarij.
Water Research WATRAG, Vol. 21, No. 11, p 1345-1354, November 1987. 7 fig, 12 tab, 4 ref.

Descriptors: *Heavy metals, *Wastewater treatment, *Industrial wastewater, Coprecipitation, Metals, Heavy metal removal, Coagulation, Flocculation, Lime, Sodium hydroxide, Arsenic, Cadmium, Chromium, Copper, Mercury, Nickel, Lead, Zinc.

Wastewater from wet lime(stone)-gypsum flue gas desulfurization (FGD) processes for coal-fired boilers contains suspended solids (gypsum, silica, hydroxides of iron and aluminum) and soluble salts (chlorides and sulfates of calcium, sodium and magnesium). Furthermore, small amounts of heavy metals such as As, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Se and Zn are present in these wastewater streams. A treatment method was developed to remove these heavy metals very efficiently. This method was based on coprecipitation of metal hydroxides and sulfides. The hydroxide and sulfide precipitates are removed by a coagulation/flocculation technique followed by gravity settling. The coprecipitation can be carried out with sodium hydroxide or with lime. Both cases were investigated in two different pilot plants with synthetically composed wastewater and with actual wastewater from three different types of wet lime(stone)-gypsum FGD plants (lime-gypsum FGD plants without a prescrubber, one using seawater and another using river water as process water; a limestone-gypsum FGD plant with a prescrubber using river water as process water). The method was particularly efficient at removing As, Cd, Cr, Cu, Hg, Ni, Pb and Zn. If lime is used to make the wastewater alkaline, crystallization of gypsum occurs resulting in more compact flocs with a high solids content. (Wood-PTT)
W88-05591

**BENZOATE REMOVAL BY AEROBIC BIOSLIMES,**
Monash Univ., Clayton (Australia). Dept. of Chemical Engineering.
G. A. Holder, and G. M. Vaughan.
Water Research WATRAG, Vol. 21, No. 11, p 1355-1362, November 1987. 10 fig, 3 tab, 8 ref.

Descriptors: *Bioslimes, *Benzoate removal, *Biological wastewater treatment, *Biodegradation, *Wastewater treatment, Aerobic biodegradation, Filtration, Biofiltration, Theoretical analysis, Mathematical equations, Biochemistry, Data interpretation, Kinetics, Simulation, Trickling filters.

Aerobic biodegradation of sodium benzoate by bioslimes supported on an inclined plane is described. The trickling filtration process was simulated under carefully controlled laboratory conditions. The conventional method for correlating trickling-filter data is to plot the percentage (or fractional) removal of BOD versus some measure of the applied loading. When this procedure was applied to the data obtained, the significance of the resulting plots was obscure. This was in spite of a rigorous theoretical analysis that took into account the relevant mass-transport and biochemical-reaction processes. The true significance of the data was shown by replotting it in terms of the mean mass-flux of benzoate into the slime layer. The procedure revealed the variations in slime utilization (due to variations in loading) among the different runs. The commonly-accepted basis of the design equations found in the literature for trickling filters is a correlation of substrate removal data in terms of fraction of substrate removed. It is shown that the conventional procedure is a basically unsatisfactory approach. Instead, plots of mean mass-flux versus some measure of the applied loading (such as mass per unit time, or inlet concentration) are recommended. The intrinsic kinetics for the benzoate-removal process within the bioslime layer was zero order and the value of the zero order rate constant is estimated to be about 1 x 10 to the minus 7th power grams/cu cm/second (at temperatures in the range 17.5-23.5 deg C). (Author's abstract)
W88-05592

**STUDIES ON THE EFFICIENCY OF A LOCAL FERTILIZER WASTE AS A LOW COST ADSORBENT,**
Roorkee Univ. (India). Dept. of Chemistry.
S. K. Srivastava, N. Pant, and N. Pal.
Water Research WATRAG, Vol. 21, No. 11, p 1389-1394, November 1987. 8 fig, 2 tab, 13 ref.

Descriptors: *Adsorbents, *Wastewater treatment, *Fertilizer wastes, *Activated carbon, Industrial wastes, Phenols, Phenol removal, Hydrogen ion concentration, Kinetics, Adsorption, Economic aspects.

Waste slurry, generated in local fertilizer plants, is converted into activated carbon in air, steam and nitrogen atmospheres. Products so obtained were characterized and used for the removal of phenols, especially 2,4-dinitrophenol (DNP). The effects of pH, kinetics of adsorption, and the effect of salts on the uptake of DNP were investigated. Carbon prepared in air exhibits good sorption capacity for DNP and the adsorption data follow both Langmuir and Freundlich models. Experiments on phenol recovery and in situ regeneration of spent carbon columns were also performed. It was observed that 5% NaOH removes almost 96% of phenol loaded on the carbon column and a treatment with HNO3 reactivates the adsorbent particles which can be used for 6-10 cycles at a stretch. Other salts present in the phenolic effluents do not affect the activity of the activated carbon. The activated carbon made from the waste slurry costs almost half the amount of other commercially available samples and has comparable activity. (Wood-PTT)
W88-05597

**REMOVAL OF ORGANICS FROM LEACHATES BY ANAEROBIC FILTER,**
Toronto Univ. (Ontario). Dept. of Civil Engineering.
J. G. Henry, D. Prasad, and H. Young.
Water Research WATRAG, Vol. 21, No. 11, p 1395-1399, November 1987. 2 fig, 3 tab, 20 ref.

Descriptors: *Landfills, *Water pollution control, *Filters, *Leachates, *Wastewater treatment, *Anaerobic filters, *Chemical oxygen demand, Organic loading, Landfills, Waste load, Detention time, Sanitary landfills, Load distribution, Biological oxygen demand, Canada.

A laboratory-scale study was conducted on two anaerobic filters at several loading rates and four hydraulic detention times. Feed substrates were landfill leachates taken from a recently opened landfill (Keele Valley) and from an older site (Brock North) which had been closed for about 8 years. The strong raw leachate from the new landfill had a Chemical Oxygen Demand (COD) of 14,000 ml/l, a Biological Oxygen Demand (BOD)/COD ratio of 0.7 and a COD/P value of 17,900. The partially stabilized leachate from the older landfill had a COD of only 3750 ml/l, a BOD/COD ratio of 0.3 and a COD/P value of 30,640. Results from the treatment of the two leachates were compared with those from a previous study of a 'mature' landfill (Beare Road). It was demonstrated that the anaerobic filter could reduce the COD of leachate from landfills of different ages by 90% at loading rates of 1.26-1.45 kl COD/cu m/day. Total biogas production ranged between 400 and 500 liters gas/k COD destroyed and methane content between 75 and 85%. No phosphorus addition was required over the loading range studied. (Author's abstract)
W88-05598

**EFFECTS OF ORGANIC TOXICANTS ON METHANE PRODUCTION AND HYDROGEN GAS LEVELS DURING THE ANAEROBIC DIGESTION OF WASTE ACTIVATED SLUDGE,**
Science Applications International Corp., Paramus, NJ.
R. F. Hickey, J. Vanderwielen, and M. S. Switzenbaum.
Water Research WATRAG, Vol. 21, No. 11, p 1417-1427, November 1987. 10 fig, 4 tab, 36 ref.

Descriptors: *Toxic wastes, *Biological wastewater treatment, *Anaerobic digestion, *Methane, *Hydrogen, *Activated sludge, *Wastewater treatment, Biological treatment, Organic compounds, Digestion, Sludge, Chloroform, Bromoethanesulfonic acid, Trichloroacetic acid, Formaldehyde, Monitoring, Activated sludge process, Wastewater, Toxicity.

Batch serum bottle assays were conducted to examine the response of the anaerobic digestion proc-

ess to inhibition induced by the pulse addition of four organic toxicants (chloroform, bromoethanesulfonic acid (BES), trichloroacetic acid (TCAA) and formaldehyde). The impact that increasing levels of inhibition of methane production had on hydrogen response and volatile fatty acid (VFA) accumulation were examined. All of the toxicants, with the exception of formaldehyde, appeared to elicit similar hydrogen response patterns and VFA accumulations for similar levels of inhibition. Results indicate that both the hydrogen and acetate catabolizing methanogenic populations were inhibited to approximately the same extent by chloroform, BES, and TCAA. Severe inhibition of methane production (>70% reduction of methane compared to controls) resulted in a rapid accumulation of hydrogen in the gaseous headspace. When inhibition was less severe, hydrogen accumulated to levels only slightly above controls. Based on these preliminary results, there appears to be some limits on the potential of using hydrogen as an early warning indicator of process upset. Results do indicate, however, that monitoring hydrogen in consort with conventional process indicators should improve digester monitoring and may provide more rapid indication of process upsets due to toxic shocks. (Author's abstract)
W88-05601

**MECHANISTIC STUDIES OF ANAEROBIC METHANE FORMATION APPLIED TO WASTEWATER TREATMENT FACILITIES,**
Duquesne Univ., Pittsburgh, PA. Dept. of Chemistry.
E. R. Malek, and T. J. Weismann.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 21, No. 1, p 5-9, January-February, 1988. 21 fig.

Descriptors: *Methane, *Methane bacteria, *Anaerobic digestion, *Hydrocarbons, *Bacterial physiology, Biodegradation, Biological treatment, Digestion, Wastewater facilities, Organic matter, Chemical reactions, Hydrogen, Carbon dioxide, Fermentation, Kelps, Phaeophyta, Sludge, Sludge digestion, Bacteria, Crude oil, Oil, Acetic acid, Hydrogen ion concentration.

Methane production was investigated from (1) salt and fresh water biomass, (2) petroleum, (3) oil shale bitumen, (4) tar sand bitumen, (5) various acetates, and (6) sludge digest. Several results of this investigation were unexpected and appear to be potentially significant in understanding the fundamental mechanisms involved in the conversion schemes employed by wastewater control facilities. The correlation of methane with pH is also discussed. (Doria-PTT)
W88-05647

**PERFORMANCE OF A RECIRCULATING SAND FILTER UTILIZING BOTTOM ASH MEDIA: PART I,**
West Virginia Univ., Morgantown.
S. W. Swanson, S. P. Dix, and C. R. Jenkins.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 21, No. 1, p 25-29, January-February, 1988. 6 fig, 1 tab.

Descriptors: *Sand filters, *Filtration, *Wastewater treatment, *Septic tanks, Septic wastewater, Performance evaluation, Filters, Pumps, Suspended solids, Oxygen demand, Biological oxygen demand, Monitoring, Disinfection, Radiation, Ultraviolet radiation, Hydraulic loading.

A recirculating sand filter (RSF) utilizing bottom ash media was built in May, 1985 for a single family residence in Monongalia County, WV. The 8 ft x 15 ft x 4.5 ft deep filter consists of three layers of media. The bottom ash layer (32 in) rests upon a pea gravel layer (6 in) and a coarse gravel layer (16 in). The gravel layers act as a storage zone for both incoming septic effluent and recirculated wastewater. An electrical timer controls two submersible pumps located within the sand filter: a recirculation pump feeds one-inch diameter, perforated polyvinyl chloride distribution lines atop the bottom ash layer; a discharge pump delivers wastewater to an ultraviolet disinfection unit, and ultimately, to a nearby trout stream. A summer/fall Monitoring program consisted of varying recirculation ratios for hydraulic loading rates of 5 and 10 gallons/day/sq ft. BOD sub 5, suspended solids (SS), and total kjeldahl nitrogen (TKN) concentrations in the RSF effluent averaged 7.9 mg/l, 7.2 mg/l, and 9.2 mg/l, respectively. Winter monitoring involved testing distribution loop arrangements with respect to ice accumulation, as well as effluent quality monitoring: BOD sub 5, SS, and TKN averaged 11.9 mg/l, 11.1 mg/l, and 8.6 mg/l, respectively. Additional evaluations were conducted upon the ultraviolet disinfection unit and a septic tank outlet filter. (Author's abstract)
W88-05649

**OFF-PEAK PUMPING OFFERS ECONOMIC BENEFITS FOR SEWERAGE SYSTEM,**
Myrtle Beach, SC.
S. Powell.
Public Works PUWOAH, Vol. 118, No. 8, p 73-75, August, 1987.

Descriptors: *Benefits, *Economic aspects, *Pumping, *Sewer systems, Peak demand, *Wastewater facilities, *Myrtle Beach, South Carolina, Costs, Operating costs, Pumping plants, Storage, Storage tanks, Oxygen, Dissolved oxygen, Oxygenation, Oxygen demand, Biological oxygen demand, Sulfides, Performance evaluation.

The City of Myrtle Beach, SC expects to save $10 to $20 million in capital costs over the next 20 years by temporarily storing peak sewage flows in a major transmission system and completing the pumping during off-peak periods. This undertaking is in lieu of expanding the capacity of pump stations and force mains to meet peak demands. The system may be the first implementation of off-peak pumping to deal with current and future capacity problems in sewage systems, and is being studied by the state Department of Health and Environmental Control for the purpose of authorizing similar construction elsewhere in the state. The characteristics of the system are discussed. So far, one installation has been completed at one of four major pumping stations on the city's principal sewage transmission line. Early operating experience has shown that the storage facility allows existing pump capacity to comfortably handle peak flows into the station, and that oxygen injection contributes to reducing sewage treatment costs. (Author's abstract)
W88-05652

**SUBMERSIBLE SEWAGE PUMPING SYSTEMS HANDBOOK.**
Lewis Publishers, Inc., Chelsea, MI. 1985. 120 p.

Descriptors: *Pumps, *Handbooks, *Wastewater facilities, Municipal wastewater, Design standards, Hydraulic systems, Hydraulic machinery, Mechanical controls, Standards, Lift stations, Maintenance.

This handbook evolved because the Submersible Wastewater Pump Association believed that too few specifiers, operators and managers of municipal sewage systems were sufficiently familiar with submersible solids-handling systems in lift station applications. It presents fundamentals, but also addresses some of the more sophisticated aspects of submersible pump systems and their components, lift stations and selection of proper equipment...how to make certain the station is installed properly, and how to establish the operating and maintenance procedures needed to ensure long, satisfactory, and economic station life. This handbook is intended to be used as a daily reference. This handbook covers the following: background information on submersible pumping systems; detailed guidelines for sizing the station and selecting the proper pumping system; electrical and mechanical controls; details of how the entire station is to be put into place and made operational; and specific guidelines on operation and maintenance procedures. (Lantz-PTT)
W88-05697

**WASTEWATER CHARACTERIZATION SURVEY, PLATTSBURGH AFB, NY,**
Air Force Occupational and Environmental Health Lab., Brooks AFB, TX.
R. D. Binovi, A. H. Riojas, and M. R. Spakowicz.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A181 346. Price codes: A04 in paper copy, A01 in microfiche. USAFOEHL Report No. 87-062EQ0159EEF, May 1987. Final Report. 51 p, 2 fig, 7 tab, 5 ref, 5 append.

Descriptors: *Wastewater treatment, *Water pollution sources, *Wastewater composition, Hazardous wastes, Chemical analysis, Ammonia, Biological oxygen demand, Plattsburgh Air Force Base, New York, Chemical oxygen demand, Oil wastes.

A survey characterizing the wastewater in the Plattsburgh Air Force Base (New York) sanitary and storm sewers was conducted by the US Air Force Occupational and Environmental Health Laboratory. The scope of the survey included characterizing the major sanitary, storm and surface water discharges from the base and determining if applicable discharge standards are being violated. A total of 31 sampling sites were evaluated including 12 sanitary, 13 surface, and 6 storm water sources. Priority pollutants were found in samples from the sanitary and storm sewers and in the streams leaving the base. Recommendations were: (1) Combustible gas detection systems should be installed in lift stations; (2) A comprehensive hazardous waste survey should be conducted to identify the source of the contaminants; (3) Respirators should be worn by personnel entering the wet well of lift stations; (4) Alternates for achieving better oil/water separation should be investigated; (5) The possibility of cross-connections between the sanitary and storm systems should be investigated; (6) Oil/water separators discharge should be determined and should be connected to the sanitary sewer system; (7) Streams should be monitored for ammonia to avoid aquatic toxicity problems; (8) The BOD/COD ratio should be determined by monitoring these parameters in the stream flowing through the Copeland Oil property; (9) Additional analysis should be conducted on the seepage from the marina beach area; and (10) A hazardous material training program should be instituted. (Author's abstract)
W88-05712

**WASTEWATER CHARACTERIZATION AND HAZARDOUS WASTE SURVEY, HICKAM AFB, HI,**
Air Force Occupational and Environmental Health Lab., Brooks AFB, TX.
For primary bibliographic entry see Field 5B.
W88-05714

**LOW-LEVEL RADIOACTIVE WASTE REGULATION: SCIENCE, POLITICS AND FEAR.**
For primary bibliographic entry see Field 5E.
W88-05805

**SELF-HELP HANDBOOK,**
For primary bibliographic entry see Field 5F.
W88-05843

**MANAGING HAZARDOUS WASTES: A PROGRAMMATIC APPROACH,**
Council of State Governments, Lexington, KY.
For primary bibliographic entry see Field 5E.
W88-05844

**POLLUTION CONTROL IN THE PETROCHEMICALS INDUSTRY,**
Tennessee Technological Univ., Cookeville.
For primary bibliographic entry see Field 5G.
W88-05851

**DESIGN AND USE OF PRESSURE SEWER SYSTEMS,**
Thrasher Engineering, Rogers, AR.
D. Thrasher.
Lewis Publishers, Chelsea, Michigan. 1987. 124 p.

Descriptors: *Wastewater disposal, *Sewers, *Design standards, *Wastewater collection, *Hydraulic structures, Pumping, Domestic wastes, Pressure sewer systems, Septic tanks, Wastewater treatment, Maintenance, Costs.

The traditional mode of collection for wastewater has been gravity sewers. One problem with this traditional solution has been the obvious fact that gravity sewers must slope downhill. This creates a situation where deep cuts are often required and large, expensive pump stations are often necessary. In addition, the location(s) of any new collection main may be restricted. These disadvantages may mean that areas with extreme variations in terrain or with other limitations will remain unsewered, sometimes to the detriment of public health. All of these disadvantages serve to increase the overall cost of any wastewater collection system. These areas have generally retained septic tank-soil absorption systems as the means of wastewater disposal. For an area that is not conducive to the on-site disposal of human waste and cannot afford the high cost of conventional wastewater collection systems, innovative collection alternatives should be considered. One such alternative is a pressurized sewer system. The two major types of pressure sewer systems are the grinder pump system and the septic tank effluent pumping (STEP) system. The grinder pump pressure sewer system is based upon the premise that the grinder pump macerates and pumps all liquids and solids, including grease. The STEP system, on the other hand, retains much of the solids and grease within the individual septic or interceptor tanks. It is also significant that neither type of pressure sewer system requires any modification of the plumbing with individual households. This allows use of pressure sewer systems without changing the general routine and habits of the users. Discussed further in this book are: preliminary design concepts and considerations; final design considerations; design methodology; equipment and material considerations; characteristics of pressure sewage; and operation and maintenance. (Lantz-PTT)
W88-05854

**INTERVENTION ANALYSIS OF SEASONAL AND NONSEASONAL DATA TO ESTIMATE TREATMENT PLANT PHOSPHORUS LOADING SHIFTS,**
Soap and Detergent Association, New York.
K. A. Booman, P. M. Berthouex, and L. Pallesen.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 479-489, 4 fig, 1 tab, 8 ref.

Descriptors: *Water quality, *Phosphorus, *Wastewater treatment, *Pollutant load, Time series analysis, Seasonal variation, Statistical models, Statistical studies.

Estimating the change in phosphorus load entering a sewage treatment plant when a detergent phosphate ban goes into effect seems to be a straightforward task. Abundant useful data exist. Simple averages have been used to characterize the levels before and after the ban. Unfortunately, this method will frequently give misleading results. Using a simple average assumes that there has been a long-term stationary (horizontal) level about which fluctuations occur. If there is a trend (stochastic or deterministic, linear or nonlinear, upward or downward), this average is not a good representation of the time series. If there is a seasonal pattern, arbitrary decisions must be made about how to 'cut out' a section of the data over which the ban took effect. An ARIMA (0,1,1) time series model has been used successfully on about 60% of the data set analyzed to date. A seasonal model has been successfully applied to three data sets. The model may be adequate for the remaining sets but the analysis is not yet complete. The effect of a detergent phosphate ban on influent wastewater treatment plant P loads appears to be about 0.3 kg/cap. yr., as of 1982. (See also W88-05862) (Lantz-PTT)
W88-05898

## 5E. Ultimate Disposal Of Wastes

**INITIAL OPERATIONS REPORT OF SLUDGE FARM,**
Black and Veatch, Aurora, CO.
C. P. Houck, S. P. Putnam, and R. C. Loehr.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 970-978, October 1987. 4 tab, 8 ref.

Descriptors: *Farming, *Land application, *Sludge disposal, *Waste disposal, *Agriculture, *Nitrogen, Mineralization, Design standards, Crop yield, Irrigation.

A sludge farm of 153 ha was placed in operation in 1983. The initial design assumptions are reviewed, the results from the initial 18 months of operations are reported, and changes in the planned management are discussed. The organic nitrogen mineralization rate appears to be higher than the design assumptions, which may reduce the total amount of nitrogen that can be applied annually. The application of thickened, dewatered, or dried sludge will help increase the allowable total sludge loading on the farm. Moisture stress of the crops inhibits crop yield, which reduces crop nitrogen uptake and, in turn, limits the amount of sludge-applied nitrogen. Optimum irrigation is necessary to avoid moisture stress. To obtain maximum crop yields, supplemental fertilizer application may be required, as determined by soil tests. Initial soil compaction resulting from construction activities related to laser leveling of fields must be overcome before maximum yields can be obtained. Periodic soil ripping or other compaction-reducing techniques may be of benefit. (Author's abstract)
W88-05160

**DETERMINING THE LIKELIHOOD OF OBTAINING A RELIABLE MODEL,**
Texas Univ. at Dallas, Richardson. Dept. of Environmental Sciences.
J. J. Warwick, and W. G. Cale.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 1102-1119, October 1987. 11 fig, 2 tab, 9 ref, append.

Descriptors: *Wastewater disposal, *Wastewater treatment, *Model studies, *Probabilistic process, *Stochastic process, *Monte Carlo method, Simulation, Mathematical studies, Equations, Calibration, Validation, Verification, Mathematical models.

A methodology utilizing Monte Carlo simulation techniques is developed to ascertain the probability (likelihood) of obtaining a model with known performance characteristics (accuracy and reliability). The mathematical model selected for investigation is the classic Streeter-Phelps dissolved oxygen equation. Monte Carlo analyses are used to quantify model output uncertainty caused by input parameter measurement error. The proposed methodology includes the three steps common to implementing any model: calibration, validation, and verification. Results indicate that typically employed sampling strategies cannot achieve adequate likelihoods of obtaining a model with acceptable performance characteristics. It is found that model performance can be optimized in terms of downstream site location and sampling frequency. Finally, a procedural outline is presented to demonstrate the application of the developed methodology to any model. (Author's abstract)
W88-05169

**SUITABILITY OF MARINE CLAYS AS HAZARDOUS WASTE SITE LINERS,**
Maine Univ., Orono. Dept. of Civil Engineering.
W. F. Brutsaert.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 1141-1148, October 1987. 2 fig, 4 tab, 12 ref.

Descriptors: *Hazardous waste disposal, *Landfills, *Waste disposal, *Clay liners, *Organic solvents, *Permeability coefficient, *Clays, *Physicochemical properties, Effluents, Minerals, Chemical reactions, Solvents.

The effects of certain solvents on the hydraulic conductivity of marine clays of Maine are evaluated. The methods and procedures fall into three categories: (1) Physico-chemical characterization of the clay soil; (2) permeameter tests; and (3) effluent analysis. Clay physico-chemical properties are described. Six variable head permeameters made of stainless steel were erected and filled with the same clay at optimum moisture content. Using water as a permeant, hydraulic conductivities (K) were determined over a three- to four-week period to ensure proper column behavior. After 36 to 40 days, permeants were changed from water to organic chemicals. A summary of the chemicals used, and of their average K- and k-values is given. The results listed do not seem to agree with this expected behavior. Permeability values are a function of the porous medium only, and therefore are not affected by fluid properties. They allow for a direct comparison between water and solvent data. Acetone values are about half those of water, methylene chloride values almost double, and toluene about the same for the two-column average. Although no solvents were expected in the effluent for at least 10 days according to pore volume calculations, small amounts dissolved in water did come through rather quickly. The appearance of the solvent as a separate phase in the effluent occurs rather abruptly, and the solvent content increases rapidly to nearly 100% of the effluent. To further evaluate the effects of solvent on the integrity of clay liners, the effluent was also sampled and analyzed for certain chemical elements. Fe, Mn, Al, and silica are usually considered indicators of dissolution. Early appearance of iron in the effluent could perhaps indicate a rapid dissolution of an amorphous coating on the crystalline minerals, or an early breakdown of discrete amorphous minerals. Results of the ion analysis in the effluent are sketchy. They are only an indication that some chemical reactions are taking place and that the experiments may be too short to be conclusive, or to be able to discern difference between solvents or trends with time. A minimum of 6 to 12 months of continued monitoring would be necessary to begin to see the long-term effects. (Alexander-PTT)
W88-05171

**GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION OF WASTEWATER TREATMENT SLUDGES AND RIVER SAND TO BE USED AS SANITARY LANDFILL CAPS,**
Kent State Univ., OH. Dept. of Geology.
M. L. Schmidt.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8604194. Ph.D Dissertation, 1985. 284 p, 55 fig, 29 tab, 51 ref, 8 append.

Descriptors: *Waste disposal, *Sand, *Sludge utilization, *Landfills, *Capping, Municipal wastewater, Geohydrology, Groundwater hydrology, Lime, Clays, Sanitary landfills, Anaerobic digestion, Wastewater treatment.

Sand is stabilized with lime sludge to develop a capping material for landfills where natural soils suitable for capping, such as clays, are unavailable. The soil properties of municipal sewage sludge and municipal water treatment sludges when mixed with native river sand were investigated. Two sources of conventional clay soil type capping material were investigated for comparison. One capping material was sampled at a municipal sanitary landfill operation in Muskogee, Oklahoma, and the other came from borrow areas in Norman, Oklahoma. Results indicate that anaerobic sewage sludge was ineffective as a soil stabilization material; but lime sludge when mixed with sand produced a soil material that increased soil density to a 107.5 pcf and reduced permeability to 4.1 x 0.00041 cm/sec. A lime sludge mixture of 20% was selected as the loading rate to achieve the desired characteristics. Results also suggest that the minimum permeability of compacted sludge is achieved at a narrow range of moisture content; the mixture is low in plasticity and does not display volume changes or cracks when dried; the designed 4:1 slopes have a high safety factor for failure because of the high internal angle of friction and increased

soil cohesion when compared to pure sand; and water infiltration into the landfill is reduced with the use of a three-layered barrier soil-wicking layer cap. (Cremmins-AEPCO)
W88-05218

**MODULAR ROCK REPLACING DRAIN FIELD APPARATUS,**
K. F. Seefert.
U. S. Patent No. 4,588,325; May 13, 1986, 10 p, 17 fig. Official Gazette of the United States Patent Office, Vol 1066, No 2, p 768, May 13, 1986.

Descriptors: *Patents, *Wastewater disposal, *Sewer systems, *Wastewater facilities, Tile drains, Conduits, Outlet channels, Effluent streams, Pipes.

A sewage disposal system uses drain field construction to maximize the exposed percolation surface area while permitting evaporation through covered mesh-like channel defining members from which lengths of drain tile are suspended. The channel forming members and a layer of cloth support the overlying back fill, while permitting absorptive and evaporative action from the channel. Suspended interiorly of the channel forming members are lengthwise connected effluent conveying conduits and/or filter elements having apertures formed for draining the effluent into the channels and the soil. Suspended interiorly of the channel from axially spaced hangers are lengthwise coupled, aperture containing conduits. As required, conforming mesh-like end caps seal the channels. Overlying the channel forming grid is a smaller mesh layer and a porous rot resistant permeable cloth that separates the soil from the channel and the contained effluent. In another embodiment, the channel forming members are formed from structurally stable perforated sheet goods that can be assembled in the trench as an inverted V from which the effluent directing conduits are suspended from wire hangers connected to each side. (Cremmins-AEPCO)
W88-05242

**LAND TREATMENT OF WASTEWATERS: A CASE STUDY OF IRRIGATED ARID ZONES,**
Centro de Economia, Legislation y Administracion del Agua, Mendoza (Argentina).
A. V. Bertranou, G. Fasciolo, C. Gomez, M. Jauregui, and O. Velez.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1243-1246, 1987. 1 fig.

Descriptors: *Land disposal, *Winery wastes, *Irrigated soils, *Fate of pollutants, *Arid zone, Soil columns, Arid lands, Wastewater, Industrial wastewater, Soil aeration, Soil physical properties, Wastewater disposal, Wastewater treatment, Argentina, Case studies, Feasibility studies, Organic matter, Potassium, Pollutants.

The feasibility of land treatment of winery wastewaters in the irrigated, arid land of central Argentina was assessed with special regard to the degree of wastewater purification by the soil and the factors which may restrict irrigation. Winery wastewaters were applied to soil columns which approximated soil bulk and density under field conditions in order to analyze the behavior of the soil. Since one of the key factors in land treatment is maintaining the soil's aerobic conditions, the irrigation water depths that preserve the aerobic conditions under normal irrigation frequencies were determined; a 12 cm irrigation depth, four times that commonly applied in the region, was attained without evidence of the clogging problems indicating anaerobic conditions. The soil organic matter removal efficiency far exceeded that expected from conventional secondary treatment. The fate of elements found in winery and distillery wastewaters was also examined. Potassium, which is found in large quantities in the wastewater, was retained by the soil. It is anticipated that continuous application of the effluent will produce an imbalance that will result in toxicity problems and magnesium deficiencies, so alternative methods of potassium removal should be sought. (Wood-PTT)
W88-05262

**TWO STAGE SLUDGE STABILIZATION,**
Gesellschaft fuer Klaranlagenausrustung und Energieverwertung m.b.H., Gladbeck (Germany, F.R.).
For primary bibliographic entry see Field 5D.
W88-05263

**EFFECT OF VINASSE ON SOIL ACIDITY,**
Sao Paulo Univ., Piracicaba (Brazil). Escola Superior de Agricultura Luiz de Queiroz.
M. E. Mattiazzo, and N. A. da Bloria.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1293-1296, 1987. 3 fig, 3 tab, 6 ref.

Descriptors: *Vinasse, *Waste disposal, *Land application, *Food-processing wastes, *Soil disposal fields, Hydrogen ion concentration, Soil bacteria, Soil properties, Aluminum, Microbial degradation.

The effect of microbial action in soils treated with vinasse on the soil acidity components was determined by examining changes in pH, exchangeable aluminum and titratable acidity. Three types of soil were used: quartzose sand, red-yellow podzolic, and latosolic B terra roxa. The soils were placed in plastic receptacles which were treated with vinasse or distilled water, and methyl bromide. There was no rise in soil pH when microbiological activity was absent due to the methyl bromide treatment. When methyl bromide treatment was discontinued, microbial activity returned to the soil with a subsequent rise in pH. The results indicate that the increase in acidity is responsible for the disappearance of aluminum. It is concluded that it is the oxidation of organic matter that is responsible for the rise in soil pH and that microbial activity is responsible for the oxidation of this organic matter and thus, for the rise in soil pH following application of vinasse. (Wood-PTT)
W88-05274

**EFFECTS OF WASTE DISCHARGES ON MISSISSIPPI RIVER SEDIMENTS,**
Illinois State Water Survey, Peoria.
For primary bibliographic entry see Field 5B.
W88-05322

**REMOVING ARSENIC FROM DRINKING WATER,**
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
For primary bibliographic entry see Field 5F.
W88-05340

**HYDROLOGIC DETECTION OF ABANDONED WELLS NEAR PROPOSED INJECTION WELLS FOR HAZARDOUS WASTE DISPOSAL,**
Lawrence Berkeley Lab., CA. Earth Sciences Div.
I. Javandel, C. F. Tsang, P. A. Witherspoon, and D. Morganwalp.
Water Resources Research WRERAO, Vol. 24, No. 2, p 261-270, February 1988. 8 fig, 7 tab, 17 ref, append. Interagency Agreement DW89931336-01-0 and DOE Contract DE-AC03-76SF00098.

Descriptors: *Pumping tests, *Path of pollutants, *Saline aquifers, *Injection wells, *Waste disposal, *Geologic fractures, *Abandoned wells, Drawdown, Monitoring wells, Aquifers, Groundwater.

Deep saline aquifers are being used for disposal of hazardous liquid wastes. A thorough knowledge of the competency of such aquifers and their confining geologic beds in permanently isolating the hazardous substances in the key to successful disposal operations. Characterization of such systems, and in particular the detection of any conduit that may permit hydraulic communication between the host aquifer and nearby freshwater aquifers, must be carried out prior to the initiation of disposal projects. In deep, multi-aquifer systems, leaking faults, abandoned wells, highly conductive fractures, or shear zones may all provide leakage paths. If not initially detected, such conduits may show no apparent effect until detection is generally too late. This study attempts to address the problem of initial detection of improperly plugged or open abandoned wells. A new analytic solution has been derived to calculate the amount of leakage from an abandoned well and the corresponding drawdown at monitoring wells. A method is proposed that can be used to detect such deep abandoned wells in the area of influence of a proposed deep injection well in a multiple-aquifer system. The method is based in pump testing the injection well. Measurement of pressure variation within the injection and/or observation well(s), coupled with the use of an new set of type curves, should reveal the distance of a leaky abandoned well to an injection wells. Extensive tables permit the determination of the leakage from the abandoned well and its variation with time. (Alexander-PTT)
W88-05440

**MEASUREMENTS OF CESIUM AND STRONTIUM DIFFUSION IN BIOTITE GNEISS,**
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W88-05532

**ONE MAN'S SLUDGE IS ANOTHER'S HARVEST,**
Sioux City, IA.
W. F. Haney, and P. Becker.
Water Engineering and Management WENMD2, vol. 134, no. 12, p 22-24 December 1987.

Descriptors: *Sludge disposal, *Municipal wastes, *Municipal wastewater, *Land application, *Wastewater disposal, Fertilizers, Wastewater facilities, Farming, Nitrogen, Fertilizers, Cost analysis.

Sioux City, Iowa, has developed an environmentally acceptable and cost-effective sludge management program that is winning the approval of local farmers. The program uses multiple transports, a high capacity nurse tank, and multiple injector units which last year applied 8300 dry tons of sludge, averaging 60-100 dry tons per day, amounting to 21,500-35,700 gpd of liquid sludge at 6% solids. The injection approach, which applies the sludge 6-8 inches below the soil surface, helps to ensure the city's compliance with environmental and social concerns associated with land application of municipal sludge. Injection results in less odor, minimum runoff and less nitrogen volatilization than with other sludge application methods. Farmers pay no fee for the sludge. In return for participating in the program, they receive substantial amounts of fertilizer, a field that has been chisel-plowed, reducing the need for subsequent tillage operations. Substantial savings are thus realized through improved soil characteristics, reduced fertilizer costs, and increased productivity. (Sand-PTT)
W88-05563

**HOW WASTEWATER TREATMENT PLANTS UTILIZE DIGESTER GAS,**
Brown and Caldwell, Pleasant Hill, CA.
D. M. O'Malley.
Water/Engineering and Management WENMD2, Vol. 134, No. 8, p 42-45, August 1987. 2 fig.

Descriptors: *Methane, *Fuel, *Anaerobic Digestion, *Sludge Digestion, *Byproducts, *Heat Transfer, *Wastewater treatment, Cogeneration, Heat Exchangers, Energy sources, Cost analysis, Wastewater facilities.

Wastewater treatment plants that use anaerobic digestion to stabilize sludge have a valuable by-product at their disposal: digester gas. Methane gas composes approximately 65% of the total digester gas produced. Carbon dioxide, water vapor, and hydrogen sulfide are the chief constituents of the remaining 35%. In a well-operated anaerobic digestion system, digester gas has a heat value of approximately 550 to 600 btu's per cubic foot, compared to about 1,000 btu's for natural gas. The per-capita production rate of sludge gas at a wastewater treatment plant is about one cubic foot per day. Among the considerations to be taken into account when using digesters gas are: type of engine, aspiration, engine cooling, heat recovery, air condition, cogeneration of electricity, and re-

covery of mechanical energy. If employed efficiently, digester gas can meet many of the energy requirements of a secondary wastewater treatment plant. Whatever the method of use, the energy value of digester gas is widely appreciated today. The sophistication of ancillary heat recovery and thermal storage equipment is likely to make digester gas utilization even more cost-effective in the years ahead. (VerNooy-PTT)
W88-05567

**HEPATITIS A VIRUS AND POLIOVIRUS 1 INACTIVATION IN ESTUARINE WATER,**
For primary bibliographic entry see Field 5B.
W88-05589

**LEGAL, ECONOMIC AND POLITICAL CONSTRAINTS ON MANAGING AGRICULTURAL DRAINAGE WATER IN CALIFORNIA,**
Westlands Water District, Fresno, CA.
For primary bibliographic entry see Field 6E.
W88-05673

**TECHNICAL SUPPLEMENT TO DREDGED MATERIAL DISPOSAL STUDY, US NAVY HOME PORT, EVERETT, WASHINGTON,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 5B.
W88-05706

**PRELIMINARY INVENTORY OF PLANKTONIC AND BENTHIC ORGANISMS AT TIMES BEACH,**
Army Engineer Waterways Experiment Station, Vicksburg, MS.
J. M. Marquenie, B. S. Schrieden, and D. K. Crawley.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A181 436. Price codes: A02 in paper copy, A01 in microfiche. Report No. R26/220. March 31, 1986. 7 p, 2 tab, 4 ref.

Descriptors: *Waste disposal, *Water pollution effects, *Wetlands, *Buffalo, *New York, *Times Beach, *Lake Erie, Dredging, Path of pollutants, Surveys, Vegetation, Fate of pollutants, Invertebrates, Toxicity, Succession, Ecosystems.

Times Beach, the confined disposal site for dredged material at Buffalo, NY. was created in 1972 and used until 1976. The site was not filled to its full capacity, resulting in an upland, a wetland and an aquatic area, which were rapidly invaded by plants and animals. By 1983, when studies were initiated, this invasion had resulted in established ecosystems. The first studies were directed toward contaminant biomobility at the site and succession of terrestrial plant communities. This communication reports the occurrence of invertebrates in the aquatic portion of Times Beach and Lake Erie. The study is intended as a very general inventory for the purpose of finding groups of possible toxicological interest. (Lantz-PTT)
W88-05723

**RESOURCE ENHANCEMENT AT HAZARDOUS WASTE SITES,**
Woodward-Clyde Consultants, Walnut Creek, CA.
For primary bibliographic entry see Field 5G.
W88-05738

**MIGRATION AND METHANOGENS - A REVIEW OF CURRENT LANDFILL GAS FIELD RESEARCH AT ANL,**
Argonne National Lab., IL.
For primary bibliographic entry see Field 5B.
W88-05748

**LOW-LEVEL RADIOACTIVE WASTE REGULATION: SCIENCE, POLITICS AND FEAR.**
Lewis Publishers, Inc., Chelsea, Michigan. 1988. 311 p. Edited by Michael E. Burns.

Descriptors: *Waste disposal, *Regulations, *Radioactive wastes, Legislation, Political aspects, Disposal sites, Nuclear powerplants, Industrial wastes, Public health, Risks, Cancer, Human diseases.

An inevitable consequence of the use of radioactive materials is the generation of radioactive wastes and the public policy debate over how they will be managed. In 1980, Congress shifted responsibility for the disposal of low-level radioactive wastes from the federal government to the states. This act represented a sharp departure from more than 30 years of virtually absolute federal control over radioactive materials. Though this plan had the enthusiastic support of the states in 1980, it now appears to have been at best a chimera. Radioactive waste management has become an increasingly complicated and controversial issue for society in recent years. This book discusses only low-level wastes, however, because Congress decided for political reasons to treat them differently than high-level wastes. The book is based in part on three symposia sponsored by the Division of Chemistry and the Law of the American Chemical Society. Each chapter is derived in full or in part from presentations made at these meetings, and includes: (1) Low-level radioactive wastes in the nuclear power industry; (2) Low-level radiation: cancer risk assessment and government regulation to protect public health; and (3) Low-level radioactive waste: can new disposal sites be found. (See W88-05806 thru W88-05808) (Lantz-PTT)
W88-05805

**LOW-LEVEL RADIOACTIVE WASTE DISPOSAL,**
Vanderbilt Univ., Nashville, TN. Dept. of Environmental and Water Resources Engineering.
F. L. Parker.
IN: Low-Level Radioactive Waste Regulation: Science, Politics and Fear. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 85-107, 8 fig, 9 tab, 37 ref, append.

Descriptors: *Radioactive wastes, *Waste disposal, *Path of pollutants, Water pollution sources, Nuclear powerplants, Radionuclides, Geohydrology, Leaching, Degradation, Solidification, Hospitals, Research laboratories.

Because low-level radioactive wastes are defined by law, some wastes are included that would not necessarily be there if disposal options were based upon the risks associated with the material. Between 1985 and 2000, it has been projected that 65% (80,000,000 cu ft) of the nation's total low-level radwaste volume will be produced by nuclear fuel cycle sources. The remaining 35% (45,000,000 cu ft) will be generated by non-fuel cycle sources, such as hospitals and research laboratories. Most of this waste will contain radionuclides (primarily 60-Co, 137-Cs, 3-H, 14-C, and 131-I) in low concentrations. Most wastes will be packaged in 55-gal drums or wooden boxes, with 50% of the packages having surface radiation dosages $< 2$ mR/hr. Although measurable movement of radionuclides onsite at three former commercial low-level radioactive waste disposal sites was found, no significant (in terms of dose) movement offsite has occurred. No significant movement of radionuclides has been detected at one site still operating in a humid region of the country nor at two study sites operating in arid regions. Because of the complex geohydrology and geochemical reactions taking place and the lack of a comprehensive mass balance study at any of the sites, no definitive conclusions on the mechanisms and rates of transport can be made about the low levels of movement that have taken place. Because degradation and solidification are accelerated in the presence of water, many of the major changes to be expected have already taken place, so that catastrophic or major releases should not be expected at some future time. However, the exact rate of future movements cannot be accurately forecast. (See also W88-05805) (Lantz-PTT)
W88-05806

**LOW-LEVEL RADIOACTIVE WASTES IN THE NUCLEAR POWER INDUSTRY,**
Electric Power Research Inst., Palo Alto, CA. Low-Level Waste and Coolant Technology Program.
For primary bibliographic entry see Field 5B.
W88-05807

**SAFER THAN SLEEPING WITH YOUR SPOUSE - THE WEST VALLEY EXPERIENCE,**
New York State Dept. of Health, Albany.
J. M. Matuszek.
IN: Low-Level Radioactive Waste Regulation: Science, Politics and Fear. Lewis Publishers, Inc., Chelsea, Michigan. 1988. p 260-277, 3 fig, 1 tab, 35 ref.

Descriptors: *Radioactive waste disposal, *West Valley, *New York, *Waste disposal, *Risk, *Waste dumps, *Underground waste disposal, *Path of pollutants, Waste management, Fate of pollutants, Health effects, Public health, Tritium, Carbon radioisotopes, Disposal sites, Radiation.

Studies of the West Valley, New York, low-level radioactive waste burial site are reviewed in terms of the following issues: entry of water into burial trenches, transport of radio nuclides out of the trenches, ultimate fate of the radionuclides, regulatory and health implications, dose levels from West Valley, and additional measures to reduce effluents. Despite burial of unacceptable waste forms and poor management of the site, annual doses from shallow-land burial at the West Valley site are well within existing and forthcoming standards. Even the maximum annual health risks, less than two in one billion for a public water supply customer and less than four in one billion for a fisherman result in lifetime risks for each which are more than 100-fold below 'one in a million,' a value commonly considered acceptable. Decomposition of buried biodegradable wastes will result in the production of large volumes of gas which in turn will create problems with management of a disposal site, even if a system is used similar to that used in France. Since tritium and 14-C will escape to the atmosphere regardless of whether or not the wastes are incinerated, management of any disposal site may be improved by incineration prior to burial. It appears that worker and public doses will increase if incineration is used, however. The potential radiation doses from West Valley burial site effluents are selection of any other currently known technology seems difficult to justify from a purely technical standpoint. (Lantz-PTT)
W88-05808

**MANAGING HAZARDOUS WASTES: A PROGRAMMATIC APPROACH,**
Council of State Governments, Lexington, KY.
J. W. Wright.
The Council of State Governments, Lexington, KY. 1986. 84 p.

Descriptors: *Waste management, *Hazardous wastes, *Management planning, *Waste disposal, Case studies, Disposal sites, Public relations, Public policy, Regulations.

The passage of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in December 1980 led to the eventual identification of some 800 high-priority waste dumps as threatening enough to qualify for federal assistance. EPA estimates that up to 2,200 sites will eventually qualify, but the United States Office of Technology Assessment (OTA) estimates that as many as 10,000 uncontrolled hazardous waste sites could qualify under EPA standards. A research study was funded by the National Science Foundation (NSF), entitled 'Risk Management and the Hazardous Waste Problem in State Governments.' As a research methodology, a case study explores a few organizations or events in depth. The state involved in the study are referred to here as the Western State and the Eastern State. Their identity is not a secret, and they are referred to by name in the research report to NSF. An effort has been made to set forth the materials in a more universally relevant format, and space required that the situations be simplified. The case studies are relatively brief summaries of the research discussed in the larger report prepared for NSF. Each of these studies attempts to relate, more or less chronologi-

cally, the sequence of decisions that were made from the initiation of action until final resolution of the threat or granting of the permit. On the basis of these four studies, conclusions are presented about the principal problems encountered by decision makers in the two states. These problems include the extended time periods involved, organizational impediments to effective programs, the impact public reactions had on the decision makers, and the paucity of information with which each decision maker had to contend. In addition, the impact of unforeseeable developments on decision-making processes is described. A number of recommendations are made for improving these types of administrative, policy-making, and decision-making processes. (Lantz-PTT)
W88-05844

**ANALYSIS OF PUMPING TESTS OF THE CULEBRA DOLOMITE CONDUCTED AT THE H-11 HYDROPAD AT THE WASTE ISOLATION PILOT PLANT (WIPP) SITE,**
INTERA Technologies, Inc., Austin, TX.
For primary bibliographic entry see Field 2F.
W88-05848

**SUPERFUND ENFORCEMENT DECISION DOCUMENT: BURLINGTON NORTHERN, MN.**
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-190054. Price codes: A03 in paper copy, A01 in microfiche.
EPA Report No. EPA/ROD/R05-86/031, June 1986. 38 p, 2 fig, 10 tab.

Descriptors: *Waste treatment, *Cleanup operations, *Burlington, *Water pollution treatment, *Water pollution control, *Minnesota, *Wastewater disposal, Coal tar, Creosote, Wastewater treatment, Groundwater pollution, Water pollution prevention, Aromatic compounds, Hydrocarbons, Phenols, Sludge, Land disposal, Organic compounds, Minnesota.

The Burlington Northern (BN) site is located in both the City of Baxter and the City of Brainerd, MN. The Mississippi River flows about 3,000 feet east of the plant and residential areas are located to the northeast and southeast, < 1,000 ft from the site. Since 1907, BN has owned and operated the railroad tie treatment plant on this site. During the 1950s BN began mixing creosote, a preserver, with Number 5 fuel oil in a 1:1 ratio. At some time, the mixture was changed to creosote and coal tar, which is being used in a 70:30 ratio. Wastewater generated from the wood treating process was sent to two shallow, unlined surface impoundments for disposal. The discharge of wastewater to the disposal ponds generated a sludge that contaminated both the underlying soils and groundwater. Groundwater contamination is restricted to a relatively small area downgradient from the site. The primary contaminants of concern include: PAHs, heterocycles, and phenols. The selected alternative for this site consists of onsite treatment and capping. Major components of the alternative include: preparation of a lined staging area for temporary storage of the sludge and contaminated soil; removal of all standing water in the impoundment; excavation and segregation of the sludges for subsequent free oil recovery; excavation of visibly contaminated soil from both impoundments and subsequent storage in the staging area; backfilling of the excavated areas; preparation of a base for the treatment area; installation of a sump for collection of the storm water and leachate; installation of an irrigation system; land treatment of creosote focusing on the breakdown and transformation of organic constituents by aerobic microorganisms in the top layer of the soil, and the immobilization of organic and inorganic constituents on the soil. The final goal of this treatment is not the complete degradation of all waste constituents, but is rather the transformation and immobilization of these constituents to render soil that is no longer toxic and does not leach harmful constituents. A final RCRA approved cover will be installed following the treatment process. The estimated capital cost for this remedy is $582,000 with annual operation and maintenance costs of $36,000. (Lantz-PTT)
W88-05849

**DESIGN AND USE OF PRESSURE SEWER SYSTEMS,**
Thrasher Engineering, Rogers, AR.
For primary bibliographic entry see Field 5D.
W88-05854

**CEMENT FIXATION STUDIES AT OAK RIDGE GASEOUS DIFFUSION PLANT,**
Oak Ridge Gaseous Diffusion Plant, TN. Process Support Div.
J. L. Shoemaker.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-005546. Price codes: A03 in paper copy, A01 in microfiche.
DOE Report No. K/PS-1236, November 1986. 32 p, 14 tab, 4 ref. DOE Contract No. DE-AC05-840R21400.

Descriptors: *Encapsulation, *Waste disposal, *Solid waste disposal, *Radioactive waste disposal, *Cements, *Sludge, *Materials testing, *Waste recovery, Recycling, Grout, Concrete, Stress.

A grout formulation was developed which allows waste sludges to be encapsulated in concrete satisfactorily and economically by mixing sludge with a dry mix composed of approximately half cement and half fly ash by weight. The addition of an air-entraining admixture and synthetic reinforcement fibers helps to reduce spalling and stress cracking. Fresh, as poured concrete, and concrete in all stages of curing passed the EPA free liquid test. Either steel drums or polypropylene bags with support molds for more symmetric shape are satisfactory containers for the wet concrete. The cast blocks or drums may be stacked after 28 days cure time. Blocks may be stacked 2 high, and drums may be stacked as high as storage yard equipment will allow. All fixed wastes exhibited structural strengths greater than EPA requirements with < 25% increase in waste volume on addition of cement and fly ash. All cement encapsulated waste materials passed the EPA standard leach test and the newly proposed TCLP test. Extensive waste stream characterization, full field test pours, and equipment testing give good assurance that the waste sludges to be encapsulated are compatible with facility design, operating procedures, and equipment. The final concrete forms should quality for delisting from hazardous to nonhazardous, and ultimately shallow-land burial. The wash water generated from cleaning concrete trucks and other equipment can be neutralized and treated, where it may be reused as wash water or discharged through a permitted release point. The STF cast concrete blocks should have sufficient integrity and durability to withstand several years of outside aging and weathering without serious deterioration, cracking, or spalling. (Lantz-PTT)
W88-05907

**CORPS' ENVIRONMENTAL EFFECTS OF DREDGING PROGRAMS,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5C.
W88-05909

**DEVELOPMENT AND APPLICATION OF TECHNIQUES FOR PREDICTING LEACHATE QUALITY IN CONFINED DISPOSAL FACILITIES: BACKGROUND AND THEORY,**
Mississippi State Univ., Mississippi State. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W88-05910

**HAZARDOUS WASTE MANAGEMENT: REDUCING THE RISK,**
B. A. Goldman, J. A. Hulme, and C. Johnson.
Island Press, Washington, DC. 1986. 316 p.

Descriptors: *Hazardous waste management, *Waste management, *Regulations, *Waste disposal, *Groundwater pollution, *Water pollution prevention, Superfund, Site selections, Disposal sites, Case studies.

Congress has strengthened the laws under which active hazardous waste facilities are regulated. Nevertheless, after visiting a number of active treatment, storage, and disposal facilities, the Council on Economic Priorities (CEP) found that not only do generators not know which facilities are the best, but that the EPA has not always selected the best facilities to receive wastes removed from Superfund sites (closed sites that endanger public health and the environment). Other facilities were better managed, better located, and better at using more advanced technologies than the facilities the EPA selected. In fact, of the ten facilities CEP evaluated in detail, the EPA chose the one that performed worst - CECOS International, Inc. in Williamsburg, Ohio - to receive Superfund wastes in more instances than any of the other nine facilities. Data from a house subcommittee survey indicate that almost half (46%) of the operating hazardous waste facilities the EPA chose to receive wastes removed from Superfund sites may have contaminated groundwater. Some of the chosen facilities may even be partially responsible for a share of the wastes they are being paid to clean up. Hazardous waste management strategies and technology, how to evaluate facilities, and case studies of various corporations and hazardous waste management facilities are discussed. (Lantz-PTT)
W88-05917

## 5F. Water Treatment and Quality Alteration

**ESTIMATING CHEMICAL DOSES FOR WATER STABILIZATION,**
Auburn Univ., AL. Dept. of Civil Engineering.
J. M. Morgan, T. M. Walski, and M. W. Corey.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1202-1218, December 1987. 6 fig, 15 ref, 2 append.

Descriptors: *Model studies, *Computer programs, *Water treatment, *Water chemistry, *Water stabilization, Lime, Carbon dioxide, Calcium carbonate, Ions, Hardness, Hydrogen ion concentration, Temperature, Computers.

A simple method was developed for directly estimating the lime and carbon dioxide doses needed to produce water that is stable with respect to calcium carbonate. The procedures employed are readily applicable using either a straightforward graphical approach or a user-friendly microcomputer program. The method is superior to Caldwell-Lawrence diagrams and the various stability indices that have been proposed in that chemical doses are obtained directly, without a trial-and-error approach. The procedures are based on numerically solving the equations governing calcium carbonate (calcite) equilibrium. The only data required are the calcium hardness, alkalinity, pH, temperature, and total dissolved solids (or ionic strength) of the water to be treated. (Author's abstract)
W88-05176

**WATER SUPPLY SYSTEMS IN BLUE NILE HEALTH PROJECT,**
Blue Nile Health Project, Wad Medani (Sudan).
O. Tameim, A. R. Daffalla, A. B. Mohamed, S. A. Basit, and A. A. El Gaddal.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1219-1233, December 1987. 8 fig, 9 tab, 8 ref.

Descriptors: *Water quality, *Blue Nile Health Project, *Domestic water supply, *Disease control, Public health, Developing countries, Cost analysis, Sudan.

Improvement of domestic water supplies is a major component of the comprehensive strategy for control of water-associated diseases in the Blue Nile Health Project of central Sudan. The value of safe water supply was confirmed in a study in 1981 that showed an inverse relationship between the rate of consumption of safe water and the prevalence of diarrheal disease and bilharzia for villages with

central supplies. Proposed improvements in water supplies would cost about $0.64/person annually in 1984 prices, to raise the consumption from the original 40 L/person/day to a design goal of 70 L/person/day. Analysis of preconstruction data indicated that these modest improvements should cause significant reductions in water-associated diseases. (Author's abstract)
W88-05177

**MOLECULAR WEIGHT EFFECTS ON THM CONTROL BY COAGULATION AND ADSORPTION,**
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
P. A. Chadik, and G. L. Amy.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1234-1248, December 1987. 9 fig, 2 tab, 35 ref. EPA Contract R809935-01.

Descriptors: *Water treatment, *Trihalomethanes, *Coagulation, *Adsorption, Natural waters, Organic carbon, Water chemistry, Molecular weight effects, Alum, Humic matter, Chlorination.

Three natural waters containing substantial levels of dissolved organic carbon were studied to assess the removal of aquatic organic matter and humic substances by coagulation and adsorption. As a general trend, alum coagulation removed higher molecular weight material, while activated carbon adsorption removed a broader molecular weight spectrum of material. This apparent selective removal of certain molecular weight ranges by a given treatment process suggests that an appropriate process can be selected to specifically remove certain organic/humic fractions that are most reactive in producing trihalomethanes upon chlorination. Moreover, if a greater degree of removal is required, the conjunctive use of coagulation and adsorption may be the best strategy for meeting this objective. (Author's abstract)
W88-05178

**ADSORPTION OF SYNTHETIC ORGANIC SHOCK LOADINGS,**
Rhode Island Univ., Kingston. Dept. of Civil and Environmental Engineering.
L. T. Thiem, D. L. Badorek, A. Johari, and E. Alkhatib.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1302-1318, December 1987. 13 fig, 1 tab, 24 ref.

Descriptors: *Water treatment, *Activated carbon, *Adsorption, *Chlorobenzenes, Organic compounds, Simulation, Pollution load, Desorption, Isotherms, Pilot plants.

A pilot plant designed to simulate conventional water treatment processes augmented by powdered activated carbon (PAC) and granular activated carbon (GAC) adsorption is operated to investigate the removal of combined shock loadings of isomers of trichloro- and tetrachlorobenzene, C-46, and C-56 present in the same influent matrix. Applications of each of the organic compounds are made as an increasing step function, with a cycle consisting of one series of four concentrations steps (2,10,100, and 200 microgram/L). In order to study desorption reactions, each step loading lasts 32 hours separated by a 24-hour period during which no applications of the organic compounds are made. A total of three cycles are evaluated; the resulting data demonstrates that PAC dosages as high as 50 mg/L are not as effective as a GAC adsorption bed with an empty bed contact time of 10 minutes. The Freundlich isotherm closely described the equilibrium condition with correlation coefficients ranging from 0.948 to 0.986 for each of the compounds. Desorption of the organics from the upper layers of the GAC bed is observed as early as the first cycle of operations. (Author's abstract)
W88-05182

**RESIDENCE TIME DISTRIBUTIONS OF SHALLOW BASINS,**
Vanderbilt Univ., Nashville, TN. Dept. of Civil and Environmental Engineering.
E. L. Thackston, F. D. Shields, and P. R. Schroeder.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1319-1332, December 1987. 7 fig, 2 tab, 15 ref.

Descriptors: *Model studies, *Retention time, *Water treatment, *Shallow basins, *Hydraulic efficiency, Winds, Depth, Mathematical studies, Prediction, Design standards, Baffles.

A analysis of data from a variety of basins showed that the strongest influence on hydraulic efficiency, t/T, was that of the length-to-width ratio, L/W. Wind and depth also had some influence. Equations were derived to show these influences and to predict t/T, so designers can know how much to increase the ideal retention time. The L/W ratio can be increased, and the adverse effects of wind can be decreased, by the use of baffles. Two baffles, producing a L/W ratio of 5-10, are usually sufficient. No reliable prediction equation for the dispersion index could be derived. (Author's abstract)
W88-05183

**RATE OF HUMIC SUBSTANCE UPTAKE DURING ACTIVATED CARBON ADSORPTION,**
Karlsruhe Univ. (Germany, F.R.). Engler-Bunte Inst.
R. S. Summers, and P. V. Roberts.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1333-1349, December 1987. 6 fig, 2 tab, 38 ref. EPA Grant R-809601.

Descriptors: *Water treatment, *Humic acids, *Adsorption, *Diffusion, *Activated carbon, *Model studies, Mathematical studies, Equations, Pores, Desorption, Ions, Molecular structure.

The adsorption-diffusion rate of a humic acid and three molecular size fractions of activated carbon was investigated over an extended time period. Long-term removal of humic substances was found that deviated significantly from the equilibrium state predicted by single-domain diffusion models. During the initial stages, i.e. up to 50% uptake, both pore and surface diffusion models adequately simulate the experimental data. Use of the pore diffusion model results in apparent tortuosities on the order of 10-20, indicating a hindered diffusion mechanism (D sub p = 0.85 times 10 to the minus twelve power to 3.5 times 10 to the minus twelve power sq m/sec). Both rate and equilibrium experiments, as well as analysis of the adsorbent pore structure, support a two-domain diffusion mechanism. No desorption of humic acid was observed in response to reducing the solution concentration or the ionic strength. (Author's abstract)
W88-05184

**EVALUATING MULTICOMPONENT COMPETITIVE ADSORPTION IN FIXED BEDS,**
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
J. C. Crittenden, T. F. Speth, D. W. Hand, P. J. Luft, and B. Lykins.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1363-1375, December 1987. 5 fig, 5 tab, 16 ref.

Descriptors: *Water treatment, *Model studies, *Fixed-bed adsorption columns, *Adsorption, Solutes, Effluents, Mass transfer, Mathematical studies, Prediction, Fixed beds, Pilot plants, Spiking.

An equilibrium column model (ECM) was developed to evaluate multicomponent competition in fixed-bed adsorption columns. The model ignores mass transfer resistances and uses ideal adsorbed solution theory to predict the competitive effects in multicomponent mixtures. The bed capacities and effluent profiles calculated from the ECM were compared to single solute capacities, and capacities and effluent profiles found from a pilot plant study. The ECM was shown to be able to calculate the elution order of the adsorbates, the lowest carbon usage rate in multicomponent mixtures, and the highest possible effluent concentrations due to competitive adsorption. Also, the ECM can be used to reduce the number of components to be specified in models that incorporate mass transfer and to select compounds that are used in spiking studies. (Author's abstract)
W88-05186

**ANEROBIC BACTERIA THAT DECHLORINATE PERCHLOROETHENE,**
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
For primary bibliographic entry see Field 5G.
W88-05195

**ECONOMICAL REMOVAL OF RADIUM FROM GROUNDWATER BY A REGENERABLE SAND FILTER AND OTHER ADSORBENTS,**
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
T. S. Mulholland.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8708006. Ph.D. Dissertation, 1986. 277 p, 65 fig, 15 tab, 97 ref, 4 append.

Descriptors: *Radium radioisotopes, *Water treatment, *Sand filters, *Adsorbents, Groundwater pollution, Drinking water, Pilot plants, Regeneration.

Simulated and actual pilot-plant groundwater studies were conducted to remove radium from groundwater using a regenerable sand filter and other adsorbents. An acid regenerable sand filter reduced the influent radium concentration to below the MCL. The field pilot plant which operated on a high hardness water exhibited decreased removals when compared to the laboratory pilot plant operated in a water of low hardness, owing to the competition from calcium and magnesium ions. The field pilot plant which was used in hard waters also had to be operated at a lower application to obtain reasonable radium removals. The concentration and volume of acid required were dependent upon influent hardness of the contaminated water. A 4 EBV pH 1 rinse was effective in all situations investigated. A pH 2 rinse would be effective in many cases, but a relatively larger volume may be required. Low flow rates of acid regenerant were as effective as relatively high flow rates. Contact time of acid with the sand filter was the controlling parameter. Sulfuric acid was as effective as hydrochloric acid and was 60% less costly. In waters of low hardness, the application rate of the influent did not seem to strongly influence the removal of radium solution by a sand filter. But in harder waters, the application rate may affect radium removals in such a filter. (Cremmins-AEPCO)
W88-05200

**TAILORING FLOCCULANT MOLECULAR STRUCTURE TO IMPROVE THE CONDITION AND DEWATERING OF WASTEWATER SLUDGES,**
Rose-Hulman Inst. of Tech., Terre Haute, IN.
For primary bibliographic entry see Field 5D.
W88-05237

**REMOVAL OF CHLORINATED SOLVENTS FROM WATER BY AIR STRIPPING,**
Institut National des Sciences Appliquees, Toulouse (France). Dept. 'Genie des Procedes Industriels'.
M. Roustan, N. Ganne, H. Roques, J. P. Duguet, and E. Brodard.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1175-1176, 1987.

Descriptors: *Volatile organic compounds, *Air stripping, *Water treatment, *Groundwater pollution, Solvents, Organic solvents, Groundwater management, Groundwater, Organic compounds, Water pollution, Chlorinated hydrocarbons, Mathematical equations.

Volatile organic compounds (VOCs) are halogenated solvents which are widely used in industrial, commercial, agricultural, and household applications. They are present in groundwater in concentrations up to 200-300 micrograms/liter. Preliminary studies showed that of the two most commonly used methods for the removal of VOCs from water, adsorption on granular activated carbon or ion exchange resins and air stripping, that air stripping is the cheaper. A counter or cocurrent packed tower was able to achieve high VOC removal efficiencies and was the least expensive option. An equation which includes relationships among the stripping factor, the efficiency, the air to water flow rate ratio, and the cross section and height of the packed column was derived for use in the design of counter current towers. (Wood-PTT)
W88-05246

**PHOTOLYTIC OZONATION OF PHENOLS,**
Drexel Univ., Philadelphia, PA. Environmental Studies Inst.
M. D. Gurol, and R. Vatistas.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1177-1180, 1987. 4 fig, 10 ref. NSF Grant CEE-8204922.

Descriptors: *Ozonation, *Phenols, *Photolytic ozonation, *Water treatment, *Ultraviolet radiation, Organic compounds, Radiation, Hydrogen ion concentration, Degradation.

It has been observed previously that ozone in combination with UV radiation is more effective in the destruction of refractory organic compounds than ozone alone. Since no detailed investigation of the mechanisms involved in ozonation in the presence of UV light has been reported, the oxidation mechanisms of phenols by photolytic ozonation were investigated. Mixtures of phenols were ozonated in the presence and absence of UV light and it was found that the reaction of molecular ozone with phenols was predominant at acidic pH under both conditions. At neutral and high pH, phenols were removed non-selectively, indicating the predominance of radical reactions. Since the rate of formation of hydroxyl radicals from hydroxide-ion catalyzed decomposition of ozone is slow, it is concluded that the phenolate ions promote the radical formation. The overall removal of phenols as a function of time was plotted for ozonation both with and without UV irradiation at a pH of 7. Although phenol removal is higher for the ozone + UV combination, it was found that the total removal was equal to the sum of removals by ozone and UV showing that the effect of combining the two techniques was additive. It is concluded that while the catalytic effect of UV light may be effective at increasing the removal of organic compounds which are relatively resistant to molecular ozone, the additional cost of UV lamps is not justifiable for phenolic compounds unless the removal of the reaction products is also of primary interest. (Wood-PTT)
W88-05247

**HEAVY METALS IN DRINKING WATERS FROM THE PARAIBA DO SUL - GUANDU RIVER SYSTEM, RIO DE JANEIRO STATE, BRAZIL,**
Universidade Federal do Rio de Janeiro (Brazil). Inst. de Biofisica.
For primary bibliographic entry see Field 5B.
W88-05248

**EUTROPHICATION IN WATER SUPPLY RESERVOIRS: GENERAL IMPACTS ON POTABLE WATER PREPARATION,**
Cagliari Univ. (Italy). Ist. di Igiene e Medicina Preventiva.
For primary bibliographic entry see Field 5C.
W88-05250

**SENSITIZED PHOTOOXIDATION FOR WASTEWATER DISINFECTION AND DETOXIFICATION,**
Tennessee Technological Univ., Cookeville. Dept. of Engineering Science and Mechanics.
For primary bibliographic entry see Field 5D.
W88-05265

**FREEZE-DRIED CULTURE: AN EFFICIENT SEED TO ALLOW FAST START-UP OF A NITRIFICATION FILTER,**
Lyonnaise des Eaux, Le Pecq (France). Lab. Central.
For primary bibliographic entry see Field 5D.
W88-05268

**BIG CHANGES AHEAD FOR DRINKING WATER INDUSTRY,**
CWC-HDR, Inc., Edmonds, WA.
G. L. Culp.
Water Engineering and Management WENMD2, Vol. 134, No. 3, p 24-26,46, March 1987. 8 tab.

Descriptors: *Drinking water, *Safe Drinking Water Act, *Water treatment, *Reviews, *Water quality control, Water quality, Water quality management, Water quality standards, Legal aspects, Filtration, Disinfection, Water supply.

The amendments to the Safe Drinking Water Act that were signed into law in June 1986 are lengthy and cover many topics. The three changes most likely to influence the water supply industry, those setting the water quality standards, requiring filtration of most surface supplies and mandating disinfection of most supplies, are discussed. Congress directed the Environmental Protection Agency (EPA) to establish maximum concentration levels within three years for all 83 compounds currently listed as potentially needing control, and to add 25 compounds every three years thereafter. In order to help define the contaminants to be added to the list, utility companies will be required to monitor specified unregulated contaminants and report the results to the EPA. The drafted requirements for filtration will make it difficult, but not impossible, for many supplies to avoid filtration. Those already filtering surface supplies may also be affected by the decrease in allowable turbidity. Filtration to produce a turbidity of 0.5 turbidity units for 95% of the time based on grab samples collected every 4 hours will be required, instead of the currently allowed, state-defined satisfactory filter performance of a monthly average of 1.0 turbidity units. Disinfection requirements are not yet finalized, but regulations are expected to include mandatory disinfection of all water supplies unless a variance is obtained. Rules for obtaining a variance and those regarding redundancy of equipment to ensure continuous operation are not yet complete. Specific suggestions are made for managers of water supply utilities with respect to assessment of current and possible additional outside sources of laboratory capabilities, filtering equipment, sampling and analytical programs. (Wood-PTT)
W88-05275

**PURITY CRUSADE TAKES ON THE DRINKING WATER INDUSTRY,**
J. V. Karaganis.
Water Engineering and Management WENMD2, Vol. 134, No. 3, p 27-29,46, March 1987.

Descriptors: *Drinking water, *Reviews, *Water treatment, *Water quality standards, *Safe Drinking Water Act, Water quality control, Water quality, Water quality management, Legal aspects, Risks, Public health, Policy making.

The 'purity crusade' for absolutely pure drinking water and the public reaction of excessive fear exacerbated by the various media and politicians to legitimate public health risks are described. The 1986 Amendments to the Safe Drinking Water Act are detailed. Suggestions are made to managers of water treatment facilities including: (1) examination of the limits of state immunity statutes for municipal operators, (2) review of scope and detail warnings given to customers, (3) review of insurance coverage, (4) consideration of aggressive and collective participation in decision-making under the Act, and (5) preparation of a case for a variance or exemption, if needed, in advance. It is stressed that a rational approach to the issue of toxics and drinking water must be developed along with a balance among judiciary, media, engineering, scientific and legal communities that protects public health while avoiding hysteria. (Wood-PTT)
W88-05276

**CHEMICALS IN THE WATER TREATMENT PROCESS,**
Black and Veatch, Kansas City, MO.
L. L. Harms.
Water Engineering and Management WENMD2, Vol. 134, No. 3, p 32-34, March 1987. 1 fig.

Descriptors: *Water treatment, *Drinking water, *Chemical treatment, *Water quality control, Water quality, Taste, Odors, Odor control, Coagulation, Filtration, Water softening, Disinfection, Fluoridation, Stabilization, Case studies, Mesa, Arizona, Hazards, Public health.

Proper selection of the chemicals used in water treatment is essential for production of aesthetically pleasing, high quality, potable water at reasonable cost. The chemicals commonly used for taste and odor control, coagulation, filtration processes, softening, disinfection, fluoridation, and stabilization are described along with their advantages and hazards. The water treatment process at Mesa, Arizona, is presented as a case study. (Wood-PTT)
W88-05278

**SECOND REPORT ON THE WATER SUPPLY OF THE PEOPLE'S REPUBLIC OF CHINA,**
Zurich Water Supply (Switzerland).
For primary bibliographic entry see Field 5B.
W88-05279

**USE OF A DYNAMIC PROGRAMMING TECHNIQUE FOR OPTIMIZING OPERATION OF A REGIONAL WATER RESOURCE SYSTEM,**
North West Water Authority, Warrington (England).
S. Walker, and T. Wyatt.
Aqua AQUAAA, No. 5, p 242-248, 1987. 8 fig, 8 ref.

Descriptors: *Water resources development, *Optimization, *Model studies, *Reservoir operation, *Water management, Resources management, Economic aspects, Lake District, England, Operating costs, Reservoirs, Costs, Water supply.

A stochastic dynamic programming technique was applied to optimize operation of the Lake District water resource system. Simulated operation with the associated 'Multiple Regime' policies indicates substantial savings in average operation costs compared with previous policies based on the analysis of critical periods within the historic flow sequences. In addition, small improvements in supply reliability are expected in terms of higher average reservoir levels. (Author's abstract)
W88-05280

**FORMULATION OF MODELS AND OPTIMIZATION OF UNTREATED WATER STORAGE OPERATIONS AT THE MERY-SUR-OISE PLANT FOR THE PRODUCTION OF DRINKING WATER,**
Compagnie Generale des Eaux, Paris (France).
C. Souteyrand, and M. Caillibotte.
Aqua AQUAAA, No. 5, p 258-263, 1987. 10 fig, 5 ref.

Descriptors: *Reservoir operation, *Reservoir storage, *Water storage, *Water control, *Water quality control, *Optimization, *Model studies, Storage reservoirs, Drinking water, Paris, France, Reservoirs, Reservoir design.

The treatment line of the Mery-sur-Oise plant, a large installation for the production of drinking water for the region near Paris, France, is fed by water obtained from the Oise River and stored for approximately three days in a retaining reservoir. A model of the internal processes of the reservoir was developed in order to facilitate the forecasting of the quality of the stored water in case of: (1) variation in the quality of the untreated water, (2)

modification in reservoir operations, (3) change in weather conditions, or (4) long-term evolution of reservoir conditions. The structure of the model and submodels is described. Data generated by the model are compared with measurements obtained during operation. Illustration of model use for management and optimization of reservoir functions and as an aid in reservoir design is provided. (Wood-PTT)
W88-05282

**REMOVAL OF NITRATE BY SLOW SULPHUR/LIMESTONE FILTRATION,**
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
J. C. Schippers, J. C. Kruithof, F. G. Mulder, and J. W. van Lieshout.
Aqua AQUAAA, No. 5, p 274-280, 1987. 9 fig, 1 tab, 7 ref.

Descriptors: *Denitrification, *Sulfur-limestone filtration, *Nitrates, *Filtration, *Water treatment, Groundwater pollution, Groundwater, Filters, Bacteria, Netherlands.

Slow sulfur-limestone filtration is a simple and reliable process for the removal of nitrate from groundwater in situations where groundwater has a low sulfur content and where infiltration is possible. In this process nitrate is removed in an upflow filter containing sulfur and limestone with help from the bacterium Thiobacillus denitrificans. The filter operates at a rate of 0.25 meters/hr without requiring backwashing and without clogging. Before denitrification, degassing of oxygen and nitrogen in the water is accomplished by a vacuum deaerator, since the presence of the gas bubbles impedes the process. After denitrification, the water is aerated and infiltrated in the soil in order to remove bacteria, biodegradable matter and turbidity. Preliminary investigations of the process feasibility were conducted at a pumping station belonging to the Gelderland Eastern Water Supply Company, The Netherlands. (Wood-PTT)
W88-05285

**EFFECT OF CHLORINE DIOXIDE WATER DISINFECTION ON HEMATOLOGIC AND SERUM PARAMETERS OF RENAL DIALYSIS PATIENTS,**
California Dept. of Health Services, Berkeley.
For primary bibliographic entry see Field 5C.
W88-05303

**OVERVIEW OF FILTRATION,**
Syracuse Univ., NY. Dept. of Civil Engineering.
R. D. Letterman.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 12, p 26-32, December 1987. 3 tab, 18 ref.

Descriptors: *Water treatment, *Filtration, *Water supply, Interception, Sedimentation, Kinetics, Head loss, Sand filters, Backwash, Granular filters, Precoat filters, Diatomaceous earth, Cartridge filters, Pretreatment of water, Coagulation, Polyelectrolytes, Flocculation, Chemical coagulation, Separation techniques, Flotation, Phytoplankton.

The design and operation of filtration systems are related to the required performance and the quality of water to be treated. Mechanisms of filtration include straining (for particles larger than pores in the medium), and nonstraining (attachment of particles to the media surface by interception, sedimentation, and Brownian diffusion). The amount of water filtered before limiting pressure drop or head loss is reached depends on the rate of particle removal and by the effect of the deposited particles on the rate of dissipation of energy within the filter medium. Several types of filters exist. Granular bed filters (rapid and slow sand filters and their variations, such as dual- or multimedia filters) are designed and operated by balancing trade-offs involving bed depth, grain size, and filtration rate. The ripening period, or decreased removal efficiency after filter cleaning, may be minimized by adding a coagulant to the backwash water. Precoat filtration with diatomaceous earth involves the passage of the suspension through a uniform layer of fine filtering material deposited on a rigid support (septum). This acts as a membrane filter. Cartridge filters are useful for point-of-use treatment of water which has little particulate matter. Pretreatment of influent may use the following processes: coagulation, flocculation, and solid-liquid separation, such as sedimentation, flotation, and low-efficiency filtration (prefiltration with a coarse-grained granular bed). A double filtration system uses high-rate granular bed filtration with coagulation, flocculation, and sedimentation before slow sand filtration. Microstraining acts as a pretreatment by removing particles through a fine stainless steel screen, usually without coagulation or flocculation. It is especially useful in removal of phytoplankton. Designs for five treatment systems are described: conventional, direct filtration with or without flocculation, slow sand filtration, and diatomaceous earth filtration. (Cassar-PTT)
W88-05316

**REPLACING SAND WITH GAC IN RAPID GRAVITY FILTERS,**
Water Research Centre, Stevenage (England).
R. A. Hyde, D. G. Hill, T. F. Zabel, and T. Burke.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 12, p 33-38, December 1987. 5 fig, 8 tab, 6 ref.

Descriptors: *Water treatment, *Filters, *Gravity filters, *Activated carbon, *Turbidity, *Sand filters, Church Wilne treatment plant, England, Head loss, Backwash, Adsorption, Microorganisms.

Rapid sand filters were converted to granular activated carbon (GAC) filter-adsorbers in a full-scale study at the Church Wilne water treatment plant near Nottingham, England. The GAC (0.6 mm, uc 1.7) was as effective as sand (0.65 mm, uc 1.2) in removing turbidity and residual coagulant. Total organic carbon (2-4 mg/liter in settled water and sand-filtered water) was reduced to <1-3 mg/liter) by GAC treatment. On the average, filter run lengths were 60% longer with GAC (72 hr) than with sand (44 hr). Backwash rate for the GAC filter was reduced by 50% to reduce GAC loss. There was no evidence of GAC degradation throughout the experimental period of 300 days. To convert a sand filter to a GAC filter, exposed metal surfaces must be painted to prevent corrosion, and provision for GAC removal must be made. Microorganisms of sanitary significance were effectively removed after GAC treatment. (Cassar-PTT)
W88-05317

**OPTIMIZING THE PLACEMENT OF GAC FILTRATION UNITS,**
Pirnie (Malcolm), Inc., White Plains, NY.
M. R. Wiesner, J. J. Rook, and F. Fiessinger.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 12, p 39-49, December 1987. 12 fig, 3 tab, 20 ref.

Descriptors: *Water treatment, *Cost analysis, *Filtration, *Activated carbon, Absorption, Sand filters, Head loss, Backwash, Organic carbon, Model studies, Turbidity.

The costs of granular activated carbon (GAC) filter-adsorbers (second-stage GAC filtration) were compared with those of the sand replacement option (first-stage GAC filtration). Simulation models of total organic carbon (TOC) adsorption and particle removal were used to describe filter performance. First-stage filtration was found to be the most cost-effective treatment option when TOC removals of <55% are sufficient. When treating waters with low TOC concentrations using a large number of adsorbers in parallel, and regenerating the GAC off-site, first-stage filtration was found to be cost-effective for TOC removals as high as 75%. Second-stage GAC adsorbers should become more cost-efficient for removal of low concentrations of TOC as conventional filters for turbidity removal are designed at higher filtration rates. (Author's abstract)
W88-05318

**IMPROVING THE INITIAL EFFLUENT QUALITY OF A DUAL-MEDIA FILTER BY COAGULANTS IN BACKWASH,**
Montana State Univ., Bozeman.
K. O. Cranston, and A. Amirtharajah.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 12, p 50-63, December 1987. 24 fig, 12 ref.

Descriptors: *Water treatment, *Filtration, *Coagulation, *Backwash, Dual-media filters, Alum, Polymers, Ripening of filter, Flocculation.

The problem of decreased effluent quality following backwashing of a filter was studied. Several theoretical concepts were developed. (1) The remnant stage of relatively low turbidity is associated with the backwash water that remains in the underdrains and within and above the media. The turbidity peak at this stage may occur as a result of particles sheared from the media at the beginning of the filtration cycle or as the media particles collide with each other at the end of backwashing. (2) During the influent mixing and particle stabilization stage, the influent disperses into the coagulant-free remnant water above the media, and the particles in the influent water become partially stabilized, which allows them to pass through the filter media. (3) Filter ripening is associated with the accumulation of particles within the pores of the media, resulting in a gradual reduction in effluent turbidity until a stable effluent quality is obtained. Alum proved to be the optimum coagulant. The backwash coagulants of this type operate by preventing partial stabilization of the initial influent particles or by forming stronger flocs with aluminum hydroxide microflocs. The optimum time for injection of coagulant into the backwash water is the time required to completely displace the filter unit volume with backwash water at the end of the backwashing. The optimum volume of backwash water is that required to displace the majority of the particles from the filter unit. Variation of the remnant volume above the filter media at the end of backwashing, without addition of coagulants to the backwash water, does not significantly affect the magnitude or duration of the filter ripening period. (Cassar-PTT)
W88-05319

**GRANULAR ACTIVATED CARBON FILTER-ADSORBER SYSTEMS,**
Illinois Univ., Urbana.
S. L. Graese, V. L. Snoeyink, and R. G. Lee.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 12, p 64-74, December 1987. 9 fig, 7 tab, 39 ref.

Descriptors: *Water treatment, *Activated carbon, *Filters, Adsorption, Organic carbon, Trihalomethanes, Sand filters, Turbidity, Connecticut Water Company, Taste control, Odor control.

The design, operation, and performance of granular activated (GAC) filter-adsorbers and their potential problems were studied by a survey of operating plants and literature review. GAC as a sand replacement is as effective or more effective than conventional filtration media for turbidity removal, providing that the proper medium size is used. GAC of >0.80-0.90 mm probably requires an increase in GAC depth or use of additional medium below the GAC bed. The larger uniformity coefficient of carbon (<2.4 compared with <1.6 for conventional media) results in more rapid head loss because of the fine carbon particles on the surface. Backwashing may remove some of these particles and reduce the rate of head loss development. Tastes and odors can be successfully controlled for 1-5 years unless odors are intense or organic concentration is high. Sand replacement filter-adsorbers do not effectively remove strongly adsorbed compounds such as trihalomethanes, volatile organics, and fractions of total organic carbon. Good removal efficiency is expected for strongly adsorbed compounds such as some of the pesticides and polynuclear aromatic hydrocarbons. Where filter-adsorbers are designed with empty bed contact times similar to those of postfilter adsorbers, earlier replacement is necessary. (Cassar-PTT)

W88-05320

SCHMUTZDECKE CHARACTERIZATION OF CLINOPTILOLITE-AMENDED SLOW SAND FILTRATION,
Westinghouse Electric Corp., Idaho Falls, ID.
D. R. McNair, R. C. Sims, D. L. Sorensen, and M. Hulbert.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 12, p 74-81, December 1987. 4 fig, 11 tab, 29 ref.

Descriptors: *Water treatment, *Filtration, *Sand filters, *Clinoptilolite, *Zeolites, Schmutzdecke, Logan River, Utah, Chlorophyll, Chlorophyta, Zeolite, Algae, Biological treatment, Giardia lamblia, Cysts, Suspended solids, Economic aspects, Films.

Studies were conducted to characterize the growth and composition of the schmutzdecke and the associated particle removal efficiency for a field-scale experimental slow sand filtration (SSF) system used for the biological treatment of Logan River water. A naturally occurring ammonium-selective zeolite, clinoptilolite, was added as a surface amendment to the sand bed of the SSF system as a reservoir of nitrogen for algae comprising the schmutzdecke. A predominance of filamentous algae at the surface of the filter was observed throughout the entire experimental period. Single-cell algae were observed at depths in the filter from 0.5 to 1 in. Particle removal was superior in clinoptilolite-amended SSF, even at filtration rates two to four times greater than conventional SSF rates. The effect of schmutzdecke maturation on the removal of Giardia lamblia cyst-size particles was also investigated. The growth of algae following the initiation of a filtration cycle, i.e., the maturation period of the schmutzdecke, was associated with an increase in the ability of the amended filter to remove Giardia lamblia cyst-size particles. The zeolite-amended SSF system treated drinking water for longer periods of time at higher filtration rates than achievable with conventional SSF without the zeolite surface amendment. (Author's abstract)
W88-05321

REPLACEMENT RULES FOR WATER MAINS,
Waterways Experiment Station, Vicksburg, MS.
T. M. Walski.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 11, p 33-37, November 1987. 1 tab, 11 ref, 1 append.

Descriptors: *Water distribution, *Water mains, *Rehabilitation, Water conveyance, Maintenance, Pipes, Leakage.

Quantitative rules for water main replacement are based on three ways in which mains age: leakage, pipe breaks, and inoperative valves; loss of internal carrying capacity is not considered. In its most general form the rule can be stated: replace a pipe when the cost of replacement equals the cost of maintenance and repair. Parameters in the equation include unit cost to replace a main, costs of a break, current break rate, rate of increase of pipe breaks, value of water saved, leakage rate, rate of increase of leakage, cost of a leak detection and repair program, cost of a valve, current rate of valve breakage, rate of increase of valve breakage, and interest rate. Suggestions are given to determine a value for each of these parameters. Since all costs and breakage rates are given per unit length, the length of pipe need not be considered. (Cassar-PTT)
W88-05323

SEATTLE'S EXPERIENCE WITH DISTRIBUTION SYSTEM SAMPLING,
Seattle Dept. of Water, WA.
R. G. Donner.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 11, p 38-41, November 1987. 2 fig, 5 ref.

Descriptors: *Water distribution, *Data acquisition, *Pollutant identification, *Sampling, *Monitoring, *Water analysis, Seattle, Washington, Plumbing, Quality control, Bacterial analysis, Copper, Lead, Water sampling, Safe Drinking Water Act, Water quality, Corrosion.

The Seattle Water Department has conducted monitoring programs that sample directly from both distribution mains and building plumbing. After water leaves the distribution system, it is subject to many influences within the customer's plumbing system, including greater corrosion, higher and more variable flow velocities, improperly applied lead solder, dissimilar metals in the system, and electrical grounding. Routine sampling is conducted at about 50 specially installed sample stands, which are constructed from 9-in steel pipe. They are usually located between the curb and sidewalk. Stands are connected to the mains with plastic service connections and are allowed to run continuously. Distribution system samples are analyzed for coliform, heterotrophic plate count, chlorine residual, and alkalinity. In addition, a separate program, known as the residential water quality monitoring program, provides information on water quality within single-family dwellings. The homeowner is furnished with sample collection containers and appropriate instructions. Parameters monitored include corrosion products, (iron, zinc, copper, lead, and cadmium), conductivity, alkalinity, sodium, total coliform, and heterotrophic plate count. Recently, larger, nonresidential buildings have been added to the monitoring program, using automatic samplers to obtain time-series data on the levels of corrosion products. (Cassar-PTT)
W88-05324

DESIGN CONSIDERATIONS AND OPERATING TIPS FOR SMALL RESIDENTIAL SYSTEMS,
Lewis Companies, Litchfield, MA.
B. W. Lewis.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 11, p 42-43, November 1987. 1 fig, 1 tab.

Descriptors: *Water distribution, *Residential water systems, *Water treatment, *Domestic water, New Hampshire, Water supply, Water storage, Storage, Pumping, Design criteria, Control systems.

Small residential community water systems have dramatically proliferated during the past several years in New Hampshire. The increase is partly the result of rapid population growth in areas not served by existing water systems. The state has established water system design criteria through the Code of Adminstration Rules to serve as a guideline for design and operation of these systems. Requirements are described for source of supply (usually wells), average and peak system demands (based on 150 gal per bedroom per day times the total number of bedrooms per system), size and design of atmospheric storage tanks, capacity (15 gal per dwelling unit per day) and air-to-water ratio in the hydropneumatic storage system, booster pumps, controls and alarms, pump station layout, and distribution system. Some recommendations based on experience are given. The atmospheric storage gage should be installed on the front of the tank. Emergency filling can be accomplished by using a 2-in camlock connector attached directly to the tank drain gate valve. Pressure relief valves should be installed on the discharge side of the pumps to avoid pressure buildup in case of control failures. Tips for operation of small water systems involve good recordkeeping, design review of older systems, and availability of persons or agencies involved with potential repairs. (Cassar-PTT)
W88-05325

USING ELEVATED STORAGE AND OFF-PEAK PUMPING TO CONTROL ENERGY COSTS,
Philadelphia Water Dept., PA.
B. S. Aptowicz, N. G. Weintraub, and C. Zitomer.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 11, p 46-49, November 1987. 3 fig, 2 tab.

Descriptors: *Water distribution, *Water storage, *Energy, *Pumping, *Reservoirs, *Cost analysis, *Pumped storage, Storage, Philadelphia, Pennsylvania, Electric power rates, Water demand, Pumping stations.

A five-year financial management plan was instituted by the Philadelphia Water Department to reduce costs in spite of a declining customer base, increasing operations costs, and increasing capital and financing requirements. A contract with the electric power supplier, including a night service rider, established an off-peak period for which rates were considerably lower than on-peak demand periods. The entire distribution system of the city, being interconnected, allowed two elevated reservoirs, Queen Lane and Belmont, to be used for storage of raw water pumped during off-peak periods. In addition, the three-basin East Park Reservoir, built in the mid-1800s, was rehabilitated to provide additional off-peak storage capacity. In 1984 the electrical savings in the operation of the Philadelphia water system were about $2 million, most of which was attributable to off-peak pumping and elevated storage. As of July 1987, despite cumulative rate increases of 20% and a 3% increase in water production, the total electrical power cost was 2.6% ($231,000) less than in July 1982. (Cassar-PTT)
W88-05326

COMPARING THREE SAMPLING DESIGNS FOR MONITORING COLIFORMS IN SMALL COMMUNITY WATER SYSTEMS,
Dartmouth Medical School, Hanover, NH.
T. A. Stukel, F. C. Reed, E. R. Greenberg, and N. J. Jacobs.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 11, p 50-54, November 1987. 2 fig, 7 tab, 6 ref. EPA Agreement CR-810895 with the Connecticut River Watershed Council.

Descriptors: *Water distribution, *Data acquisition, *Pollutant identification, *Water analysis, *Sampling, *Coliforms, *Monitoring, Water supply, Rural areas, Drinking water, Bacterial analysis, Water quality.

Three sampling designs--weekly, monthly, and spatial cluster--were compared to determine their effectiveness in detecting coliform contamination in small community drinking water systems. Water samples were collected over a one-year period from 15 systems in rural Vermont and New Hampshire. Sampling five times a month, regardless of whether samples were collected simultaneously at five different sites within a system (spatial cluster) or once a week at the same site, detected between 50 and 100% more incidents of contamination than were found by sampling once a month. The spatial cluster design was slightly more sensitive than the weekly sampling design in its ability to detect coliform contamination. (Author's abstract)
W88-05327

MODELING THE PROPAGATION OF WATERBORNE SUBSTANCES IN DISTRIBUTION NETWORKS,
Idaho Univ., Moscow. Dept. of Civil Engineering.
C. P. Liou, and J. R. Kroon.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 11, p 54-58, November 1987. 7 fig, 6 ref.

Descriptors: *Water distribution, *Water quality, *Pipelines, *Path of Pollutants, *Hydraulics, Model studies, Computer models, Mixing, Carlisle, Pennsylvania, Pipe flow, Flow.

An algorithm was developed to model the propagation of a waterborne substance (contaminants, disinfectants, turbidity, hardness, etc.) through space and time in general networks with constant or variable flow conditions. The algorithm models the advection of a constituent in pipelines, the decay or growth of the constituent with time, and the mixing of multiple streams at junctions. Required input includes parameters required for regular network hydraulic analysis, concentration of the substance at the source(s), and the reaction rate constant if the substance is nonconservative. The

model was used on data from the water distribution system of Carlisle, Pennsylvania. (Cassar-PTT)
W88-05328

**FREQUENCY-OF-OCCURRENCE MONITORING FOR COLIFORM BACTERIA IN SMALL WATER SYSTEMS,**
Drexel Univ., Philadelphia, PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W88-05329

**TREATABILITY OF MANGANESE BY SODIUM SILICATE AND CHLORINE,**
Tennessee Univ., Knoxville. Dept. of Civil Engineering.
F. B. Robinson, and S. K. Ronk.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 11, p 64-70, November 1987. 6 fig, 3 tab, 22 ref.

Descriptors: *Water treatment, *Manganese, *Chlorination, *Sodium silicate, Sodium hypochlorite, Hypochlorites, Filtration, Sequestration.

Manganese sequestering by nearly simultaneous additions of sodium silicate and sodium hypochlorite was studied in laboratory-prepared waters. Under conditions of near-neutral pH and 150-250 mg/liter of alkalinity as CaCO3, 1-2 mg manganese/liter could be sequestered for up to one day. Less effective manganese treatability was found at pH 8 than at pH 7. Additionally, at pH 7 the best results were obtained when neither silicate nor hypochlorite was added because of the slow manganese oxidation rate by oxygen alone. Aging of diluted stock silicate solutions prior to dosing also resulted in poor treatment; the presence of background silica increased the treatment effectiveness only slightly. Overall, manganese was less treatable by this method than iron under the same treatment conditions. (Author's abstract)
W88-05330

**EVALUATING ALTERNATIVE COAGULANTS TO DETERMINE EFFICIENCY AND COST EFFECTIVENESS,**
Philadelphia Water Dept., PA.
W. R. McKeon, and J. J. Muldowney.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 11, p 71-75, November 1987. 7 fig, 4 tab, 8 ref.

Descriptors: *Water treatment, *Coagulation, *Cost analysis, Philadelphia, Pennsylvania, Iron compounds, Chemical coagulation.

Ferrous sulfate was studied as an alternative coagulant to ferric chloride. Coagulants were evaluated for iron content, heavy metal contaminants, acidity, chlorine demand, and settleable solids. Jar tests and split-plant trials demonstrated similar performance at comparable costs with either coagulant. An anomaly that was evident throughout the study was that a pound of iron in the form of ferrous sulfate was 20% more effective than iron as ferric chloride. An equation was developed to compare ferric chloride and ferrous sulfate on a cost and performance basis for subsequent bids. As a result of the increased competition in bidding, there was a 50% decrease in the cost of coagulant over a three-year period. (Author's abstract)
W88-05331

**TECHNICAL NOTE: THE FORMATION OF CHLORATE FROM THE REACTION OF CHLORINE AND CHLORITE IN DILUTE AQUEOUS SOLUTION,**
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
P. C. Singer, and W. K. O'Neil.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 11, p 75-76, November 1987. 2 fig, 2 ref.

Descriptors: *Water treatment, *Chlorination, *Disinfection, Chlorates, Chlorites, Chemical reactions.

Previously published conclusions that chlorate is the principle product of the reaction between chlorite and chlorine in oxidant-demand-free, dilute solution at pH 7 were confirmed. Higher initial concentrations (about 5 mg/liter) were used so that the residual species concentrations could be measured with greater precision than in the original study. During the 160-hour reaction period the original concentrations of reactants were reduced to about 2 mg/liter, and the chlorate concentration reached about 4.5 mg/liter. (Cassar-PTT)
W88-05332

**COMPUTER CONTROL OF A DISTRIBUTION SYSTEM,**
Columbus Dept. of Public Service, OH. Div. of Water.
J. R. Doutt.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 11, p 78-79, November 1987.

Descriptors: *Water distribution, *Computers, *Control systems, *Automation, Columbus, Ohio.

The three separate treatment systems of the Columbus, Ohio, water system operated with separate staffs and equipment but were interdependent. The master plan for automating the system included three key elements: (1) involvement of operations and maintenance personnel from the beginning of the design phase, (2) automation of the distribution system before the treatment plants, considering the clearwell storage as the boundary between distribution system and treatment, and (3) consideration of only standard, readily available and tested hardware and software (no prototypes). Starting with the control center, the 60 separate facilities were phased into the system. Before each facility was brought into the system, the equipment was field tested to prevent startup problems. (Cassar-PTT)
W88-05333

**RESERVOIR MANAGEMENT,**
Waco City Environmental Quality and Water Purficiation Dept. (Texas).
For primary bibliographic entry see Field 5G.
W88-05334

**ESTABLISHING A MAINTENANCE PROGRAM,**
Water and Sanitation for Health Project, Arlington, VA.
J. K. Jordan.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 8, p 32-36, August 1987. 2 fig.

Descriptors: *Water treatment facilities, *Maintenance, Washington Suburban Sanitary Commission, Personnel, Management, Training, Inventory control, Recordkeeping.

Guidelines are given for planning and implementing a maintenance program for water treatment plants. Advantages of such a program include improved reliability of the system, safety conditions, and employee morale; increased equipment life and available operation information; fewer equipment breakdowns; and decreased downtime and time required for maintenance work. The characteristics of the system must be determined (size, number of personnel, complexity of plant operation, identification of equipment parts, etc.). A manual control system is satisfactory for a small to medium-sized utility operating a single treatment plant. Larger systems may need an automated system. Key elements of a maintenance program include identification numbers for all equipment and parts, a system for issuing work orders, provision for feedback and control, accountability for resources expended, and a maintenance history for each piece of equipment. Tasks needed to be performed must be identified and then categorized according to frequency of performance (daily, weekly, etc.). Procedure sheets must be prepared for each task. Techniques to monitor the scheduled maintenance tasks can be manual, automated, or graphic. Enhancements to a maintenance program are inventory control for parts, good communication with purchasing personnel, performance and productivity monitoring of the maintenance staff, and appropriate management reports. Training needs to be carefully planned for four different groups: field personnel, maintenance management team, upper management, and operations supervision. (Cassar-PTT)
W88-05335

**ORGANIC CONTAMINATION OF GROUNDWATER: A LEARNING EXPERIENCE,**
Hawaii Univ., Honolulu. Water Resources Research Center.
For primary bibliographic entry see Field 7B.
W88-05336

**REMOVING MANGANESE FROM WATER AT FREDERICTON, N.B., CANADA,**
Regina Univ. (Saskatchewan). Faculty of Engineering.
T. Viraraghavan, E. L. Winchester, G.J. Brown, G. P. Watson, and R. C. Landine.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 8, p 43-48, August 1987. 5 fig, 6 tab, 4 ref.

Descriptors: *Water treatment, *Manganese, *Water quality, Fredericton, New Brunswick, Filtration, Chlorination, Sulfur dioxide, Chemical precipitation.

Pilot studies were done on removal of manganese at levels of about 0.5 to 2 mg/liter from raw water used by the Fredericton, New Brunswick, water treatment plant. One system was a conventional manganese green-sand filter that used chlorine and potassium permanganate as oxidants. A second system was a new type of filter media (electromedia) that used chlorine as the oxidant. Manganese was efficiently removed by both processes so that sampling usually showed levels of 0.01 to 0.05 mg/liter, except for occasional higher levels when media became coated or when backwash was needed. Based on economic analysis the chlorination-filtration system was recommended. The proposed system will have 5 wells, a pressure filtration system consisting of 2 reaction vessels and 3 filter vessels, a vacuum-operated chlorine and sulfur dioxide feed system, feed equipment for hydrated lime and soda ash, decant tanks for sludge treatment, heat recovery system, and automated control. (Cassar-PTT)
W88-05337

**REMOVING VOCS FROM GROUNDWATER CONTAINING HUMIC SUBSTANCES BY MEANS OF COUPLED AIR STRIPPING AND ADSORPTION,**
Arizona Univ., Tucson. Dept. of Civil Engineering.
G. L. Amy, R. M. Narbaitz, and W. J. Cooper.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 8, p 49-54, August 1987. 4 fig, 4 tab, 15 ref.

Descriptors: *Water treatment, *Humic acids, *Adsorption, *Activated carbon, *Aeration, Organic compounds, Carbon tetrachloride, Trichloroethylene, Air stripping, Volatile organics, Chlorinated hydrocarbons, Groundwater.

Sequential air stripping and activated carbon adsorption were used for removing trichloroethylene (TCE) and carbon tetrachloride (CT) from groundwater (Biscayne Aquifer) containing a high background level of organic carbon. Although both compounds were effectively removed by either process, TCE was more amenable to removal by adsorption, whereas CT was more amenable to removal by stripping. Background levels of organic carbon were found to affect adsorption of both TCE and CT significantly, reducing observed sorbent loadings. (Author's abstract)
W88-05338

**USING REVERSE OSMOSIS TO REMOVE AGRICULTURAL CHEMICALS FROM GROUNDWATER,**
Suffolk County Dept. of Health Services, Haup-

pauge, NY.
J. H. Baier, B. W. Lykins, C. A. Fronk, and S. J. Kramer.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 8, p 55-60, August 1987. 4 fig, 10 tab, 6 ref.

Descriptors: *Water treatment, *Reverse osmosis, *Membrane processes, *Pesticides, *Agricultural chemicals, Groundwater, Organic compounds, Wells, Aldicarb, Carbofuran, Dichloropropane, Trichloropropane, Suffolk County, New York.

Studies were conducted on reverse osmosis equipment to remove aldicarb, carbofuran, 1,2-dichloropropane, and 1,2,3-trichloropropane from Suffolk County, New York, well water. Seven membranes (celluloae acetate, spiral wound, and hollow fiber) were screened on the field scale. Conclusions are (1) cellulose acetate effectively removes carbamates (aldicarb and carbofuran) but not the chloropropanes, (2) polyamides remove carbamates, organics, and nitrates, (3) the spiral-wound polyamide did not perform as well as the hollow-fiber configuration from the same manufacturer, and (4) the hollow-fiber membrane consistently recovered more water at the same operating pressure of 160 psi. Reverse osmosis should be considered for removal of organics and pesticides. Pilot tests should be performed using in situ water to provide proper process design. (Cassar-PTT)
W88-05339

**REMOVING ARSENIC FROM DRINKING WATER,**
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
S. W. Hathaway, and R. Rubel.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 8, p 61-65, August 1987. 3 fig, 4 tab, 6 ref.

Descriptors: *Water treatment, *Arsenic, *Waste disposal, Fallon, Nevada, Operating costs, Capital costs, Land disposal, Alumina, Ion exchange, Drinking water, Metals, Heavy metals, Chlorination.

Pilot-plant tests of two treatment methods, activated alumina and ion exchange, for removing arsenic from drinking water were evaluated at the Fallon, Nevada, Naval Air Station (NAS). The arsenic concentration was 0.080-0.116 mg/liter, exceeding the 0.05 mg/liter maximum contaminant level. Although the valence of arsenic was not determined, the prechlorination process and test results suggest it was probably arsenic V. Chlorinated drinking water from the NAS was used for evaluating the efficacy of treatment under several different conditions. The activated alumina and ion exchange systems were operated through three different loading and regeneration cycles each. The major water quality factors affecting the removal of arsenic by these methods were pH of feedwater, arsenic concentration, sulfate concentration, and alkalinity. The major operational factors affecting removal were flow rate, down time, and media clogging. Capital and operating costs for arsenic removal are estimated for the activated alumina method at optimum pH (5.5) for each of the three small community systems drawing water from the same aquifer. In addition, several containers of the regeneration waste were used for a special study to characterize, dewater, and render the waste nontoxic for disposal in a sanitary landfill. (Author's abstract)
W88-05340

**STRONG-ACID ION EXCHANGE FOR REMOVING BARIUM, RADIUM, AND HARDNESS,**
Illinois Univ., Urbana. Dept. of Civil Engineering.
V.L. Snoeyink, C. Cairns-Chambers, and J. L. Pfeffer.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 8, p 66-72, August 1987. 6 fig, 3 tab, 16 ref. EPA Contract CR-808912.

Descriptors: *Water treatment, *Ion exchange, *Barium, *Radium, *Hardness, Metals, Heavy metals, Radioisotopes.

The performance of conventional sodium-form strong-acid ion exchange resins for removal of barium, radium, and hardness was studied under laboratory conditions. One reason for this research was the problem of premature barium leakage reported with these columns. The test water contained 1.0 mM CaCO3, 1.0 mM MgCO3, 0.15 mM BaCl2, 1.7 mM NaHCO3, and 20 pCi Ra-226 per liter. The resin had a polystyrene-divinylbenzene crosslinked matrix with sulfonate functional groups. The resin provided good removal of hardness and removal to below the drinking water maximum contaminant level (MCL) for Ba and Ra. Satisfactory Ba removal was possible as long as the resin was not exhausted for hardness removal and sufficient regenerant was applied. Likewise Ra was removed to below its MCL of 5 pCi/liter even after the resin was saturated with hardness and Ba. There was no indication that the Ra would accumulate on the resin to levels that would cause the MCL to be exceeded during the softening run.(Cassar-PTT)
W88-05341

**APPLYING MEMBRANE PROCESSES TO GROUNDWATER SOURCES FOR TRIHALOMETHANE PRECURSOR CONTROL,**
University of Central Florida, Orlando. Dept. of Civil Engineering and Environmental Sciences.
J. S. Taylor, D. M. Thompson, and J. K. Carswell.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 8, p 72-82, August 1987. 18 fig, 14 tab, 39 ref.

Descriptors: *Water treatment, *Membrane processes, *Organic matter, *Chlorinated hydrocarbons, Organic compounds, Trihalomethanes, Reverse osmosis, Operating costs, Capital costs, Ultrafiltration.

Trihalomethane (THM) control using membrane processes was investigated for two groundwater sources (near West Palm Beach, Florida) containing excessive THM precursors. Seven membranes, with molecular weight cutoffs (MWCs) of 400 to 40,000 were used. The nanofilter membrane (MWC of 400) controlled the THM formation potential to less than the 0.10 mg/liter maximum contaminant level (MCL). The reverse osmosis membrane (MWC of 100) did not reduce the THM formation potential significantly more than the nanofilter. Ultrafilters with MWCs equal to or greater than 2000 did not reject enough THM precursors to meet the MCL at these sites. Data obtained from pilot plant runs produced cost estimates for a 1-2.5 mgd membrane system using a high-organic-low total dissolved solids source. Capital costs were estimated at $1.32 to $1.14 per gal of permeate; operating costs, $0.680 to $0.545/1000 gal. (Cassar-PTT)
W88-05342

**WATER DISTRICT'S RECOVERY FROM STORM DAMAGE,**
San Lorenzo Valley Water District, Boulder Creek, CA.
For primary bibliographic entry see Field 8A.
W88-05345

**AURORA ADOPTS INNOVATIVE WATER TREATMENT SYSTEM,**
Aurora Public Works Dept., IL.
J. Nanninga.
Public Works PUWOAH, Vol. 118, No. 10, p 82-83, October 1987. 1 tab.

Descriptors: *Water treatment, *Radium, *Clarifiers, ClariCone, Water supply, Aurora, Illinois.

Mandated radium compliance by 1990 and rapid population and industrial expansion forced the city of Aurora, Illinois, to study alternatives for water supply needs. The ClariCone clarifier was incorporated into the water treatment plant design. This upflow clarifier has virtually no moving parts. The effluent acts to collect precipitated contaminants. Raw water and slaked lime enter the bottom of the inverted cone in a tangential orientation, spiralling and decelerating as the fluid proceeds upward. Near the top of the ClariCone is a floating mass that traps precipitating materials. This mass is periodically drawn off through a center pipe. As the water leaves the ClariCone, it passes through self-contained steel shell filters, after which it is stored in finished water tanks. Six 51-ft diameter ClariCones, with a capacity of 5 mgd each, will be installed to handle water from three sources: deep wells, shallow wells, and the Fox River. (Cassar-PTT)
W88-05349

**GROUNDWATER, IRON AND MANGANESE: AN UNWELCOME TRIO,**
HKM Associates, Billings, MT.
N. Kothari.
WATER/Engineering and Management WENMD2, Vol. 135, No. 2, p 25-26, February 1988.

Descriptors: *Iron, *Manganese, *Groundwater pollution, *Demineralization, *Chemical oxidation, *Ion exchange, *Water treatment, Iron bacteria, Aesthetics, Hydrogen ion concentration, Alkalinity, Dissolved oxygen, Temperature.

Iron and manganese are natural constituents of the earth's crust and both elements create serious aesthetic problems in drinking water supplies. The occurrence of iron and manganese in groundwater, and problems arising from their presence, are reviewed. Four commonly used methods for iron and manganese removal are direct oxidation, addition of oxidation agents, ion exchange, and stabilization. These methods are discussed, as well as factors affecting iron and manganese removal, such as temperature, pH, dissolved oxygen, alkalinity, and other ions present. The above factors affect the removal methods differently and for these reasons, laboratory testing and studies should be made to evaluate the treatability of a water supply for iron and manganese removal. (VerNooy-PTT)
W88-05350

**MAJOR OZONATION/DIRECT FILTRATION WATER TREATMENT FACILITY,**
Hackensack Water Co., Harrington Park, NJ.
R. McKeon, and L. Gross.
Public Works PUWOAH, Vol. 118, No. 9, p 90-92, September 1987.

Descriptors: *Water treatment, *Ozonation, *Filtration, *Chlorination, Hackensack, New Jersey, Flotation, Disinfection, Pilot plants.

The 200 mgd Haworth Expansion of the Hackensack (NJ) Water Company is currently under construction. This facility will use ozonation and direct filtration to treat water which typically contains iron, manganese, color, turbidity and trihalomethane precursors. The raw water will be dosed with alum and cationic polymer before entering the ozone contact chamber. Maximum water depth will be 27.6 ft. Fine bubbles of ozone-treated air will be sheared into the coagulant-treated water by turbine diffusers. Contact time will be 5 min; ozone dosage, 1.3 mg/liter. Flotation will remove about 20% of the total solids as microflocs. The remaining solids will be removed by dual media filters containing anthracite and sand. Chlorination will remove manganese and provide residual disinfection. Pilot studies showed that the quality of the ozone-treated water was obviously better than the present product. (Cassar-PTT)
W88-05351

**INDIRECT DETERMINATION OF FLUORIDE IN WATERS WITH LANTHANUM ALIZARIN COMPLEXONE AND INDUCTIVELY COUPLED PLASMA EMISSION SPECTROMETRY,**
National Research Inst. for Pollution and Resources, Yatabe (Japan).
For primary bibliographic entry see Field 7B.
W88-05358

**CHEMICAL CHANGES OF ORGANIC COMPOUNDS IN CHLORINATED WATER. XIV. CHARACTERIZATION AND DETERMINATION OF HALOGENATED ORGANICS**

**FORMED DURING CHLORINATION OF WATER FROM THE TAMA RIVER,**
Tokyo Univ. of Science (Japan). Faculty of Pharmaceutical Sciences.
For primary bibliographic entry see Field 5A.
W88-05365

**SIMPLIFIED METHOD TO QUANTIFY GEOSMIN AND 2-METHYLISOBORNEOL CONCENTRATIONS IN WATER AND MICROBIOLOGICAL CULTURES,**
Agricultural Research Service, New Orleans, LA. Southern Regional Research Center.
For primary bibliographic entry see Field 5A.
W88-05366

**FOOTHILLS: A STATE-OF-THE-ART WATER TREATMENT PLANT,**
Denver Water Dept., CO.
R. K. Weir, and R. L. Chapman.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 9, p 66-73, September 1987. 3 fig, 4 tab.

Descriptors: *Water treatment facilities, *Case studies, *Water treatment, Foothills water treatment plant, Denver, Colorado, Operating costs, Economic aspects, Costs, Solids, Hydroelectric plants, Coagulation, Flocculation, Sedimentation, Water quality.

After three years of operation, the showcase Foothills water treatment plant, serving the base needs of the Denver, Colorado, metropolitan area, has been performing at, or above, expectations. Taking hydraulic advantage of its location above the city, the plant's pumping costs are minimal and the plant's hydro turbine generates enough power to operate the facilities and sell excess electricity. A minimum staff can operate the automatically controlled processes. The design enables operators to choose the total treatment process or bypass coagulation, flocculation and sedimentation to minimize operation and maintenance costs, depending on seasonal water quality. Solids drying beds take advantage of the climate, further lowering treatment costs, which in 1986 averaged only about 0.03 dollars per thousand gallons. (Author's abstract)
W88-05382

**UPGRADING A LANDMARK WATER TREATMENT PLANT,**
Brown and Caldwell, Atlanta, GA.
J. G. Smith, D. L. Tippin, M. C. Bennet, and J. B. Salgaonkar.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 9, p 74-81, September 1987. 11 fig, 1 tab, 6 ref.

Descriptors: *Water treatment facilities, *Peak demand, *Water treatment, Case study, American landmarks, Tampa, Mixing, Sludge removal, Florida, Economic aspects, Operating costs, Water demand.

By 1982, rapid growth in the metropolitan area of Tampa, Florida, had increased the demand for water beyond the capacity of the city's only water treatment plant. Designated an American Water Works Association American Landmark, the Hillsborough River plant had been enlarged three times previously since its construction in 1925. The latest expansion, which was completed last year, added 36 mgd (136,000 cu m/day)of capacity without constructing new settling basins by modifying existing process units. Removal of hydraulic bottlenecks, rapid mixing facilities, and the sludge removal system increased capacity without major new construction, saving about half the estimated cost of new settling basins. The increased capacity allows the city to satisfy peak water demands with only four treatment units instead of the ten units used three years ago. The operation and maintenance of the plant was also simplified and site space for further expansion to meet future demand was saved. (Wood-PTT)
W88-05383

**EVALUATING TREATMENT PLANTS FOR PARTICULATE CONTAMINANT REMOVAL,**
Environmental Protection Agency, Cincinnati, OH. Microbiological Treatment Branch.
G. S. Logsdon.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 9, p 82-92, September 1987. 2 fig, 48 ref.

Descriptors: *Particulate matter, *Turbidity, *Water treatment, *Filtration, *Chemical coagulation, Evaluation, Water treatment facilities, Coagulation, Particle removal, Chemical treatment, Operating policies, Sedimentation.

Guidelines are presented for the evaluation of water treatment plants in order to lower the turbidity of finished water produced from filtration plants in which chemical coagulation is part of the treatment process. Ineffective removal of turbidity is related to several factors, including the physical condition of the facilities, the hydraulics of treatment processes, the quality of water, and the competence of the operating staff. Common problems affecting plant hydraulics and flow patterns, chemical feed selection and control, rapid mixing, flocculation, sedimentation and filtration were detailed along with examples of plant improvements for specific cases. Preplanning of evaluations so that all necessary and important aspects of the plant and its operations are considered in a logical fashion is suggested. (Wood-PTT)
W88-05384

**DESIGN OPTIONS FOR WATER FILTRATION,**
Camp, Dresser and McKee, Inc., Walnut Creek, CA.
R. D. G. Monk.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 9, p 93-106, September 1987. 9 fig, 6 tab, 36 ref.

Descriptors: *Gravity filters, *Filtration, *Water treatment, *Design criteria, Filters, Economic aspects, Cost analysis, Filter media, Filter rate, Backwash, Scour.

Options for a gravity filtration unit must be carefully evaluated before an optimum design can be finalized. A number of alternatives are explained and their advantages and disadvantages are detailed. The interrelationships of the components of a filtration system, including the filter media, underdrain system, backwash system, auxiliary scour, mode of operational control, backwash troughs, filtration rates, depth of the filter box, number and configuration of filters, and provisions for filter conditioning and monitoring are reviewed. Three typical hypothetical examples are presented to demonstrate the selection process and the reasons for adopting different combinations of options when designing a filter under differing climatic and socioeconomic conditions. The selections were also based on cost evaluations in order to arrive at the most cost-effective alternative practical under the given conditions. (Wood-PTT)
W88-05385

**CHLORINE DIOXIDE EFFECTS ON THMFP, TOXFP, AND THE FORMATION OF INORGANIC BY-PRODUCTS,**
Cincinnati Water Works, OH.
K. S. Werdehoff, and P. C. Singer.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 9, p 107-113, September 1987. 13 fig, 3 tab, 32 ref. USEPA Cooperative Agreement CR811108.

Descriptors: *Chlorine dioxide, *Pretreatment of water, *Water treatment, *Trihalomethanes, *Organic halides, Organic compounds, Halides, Chlorite, Halogens, Formation potentials, Byproducts, Chlorination.

An investigation of raw and finished waters was conducted (1) to determine whether chlorine dioxide pretreatment lowers trihalomethane (THM) and total organic halides (TOX) formation, (2) to evaluated the rate of chlorine dioxide consumption and the corresponding rate and extent of chlorite formation, and (3) to investigate the stability of chlorite in treated water and its interaction with chlorine. Results of these experiments showed that chlorine dioxide can reduce THM and TOX precursor concentrations and that when added to raw water, chlorine dioxide will not persist long enough to maintain oxidizing conditions through flocculation-sedimentation basins. Utilities should be able to meet the recommended limit of 1.0 milligrams/liter for the sum of the residual chlorine dioxide species by not exceeding a chlorine dioxide dosage of 1.2-1.4 milligrams/liter. (Author's abstract)
W88-05386

**INFLUENCE OF BROMIDE ION ON ORGANIC CHLORINE AND ORGANIC BROMINE FORMATION DURING FREE CHLORINATION,**
Houston Univ., TX. Dept. of Civil Engineering.
J. M. Symons, P. L. K. Fu, R. C. Dressman, and A. A. Stevens.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 9, p 114-118, September 1987. 3 fig, 9 ref. USEPA Cooperative Agreement CR811659-01-0.

Descriptors: *Bromides, *Water treatment, *Chlorination, *Chemical analysis, *Bromine, *Chlorine, Neutron activation analysis, Organic compounds, Halogens, Trihalomethanes, Drinking water, Chemical reactions, Hydrogen ion concentration, Groundwater.

The influence of bromide ion on the formation of nonpurgeable organic bromine and nonpurgeable organic chlorine was not studied previously because no analytical technique existed that could separately measure total organic chlorine and total organic bromine. This measurement was made possible with the application of the neutron activation analysis. The influence of bromide concentrations on the relative amounts of nonpurgeable organic chlorine and bromine and chlorine-substituted and bromine-substituted trihalomethanes formed during the free chlorination of drinking water over various reaction times and pH values was thus determined. The presence of the bromide ion during free chlorination did not appreciably change the amount of organic halides produced in micromoles/liter, but did alter the composition of the total organic halides produced. Measurements of this type are important because bromide ion concentrations are not lowered by conventional drinking water treatment processes, bromide ion is present in many groundwaters, bromide ion may increase the production of trihalomethanes, and the health effects of bromine-substituted compounds may be different from those of their chlorine-substituted counterparts. (Wood-PTT)
W88-05387

**COMMITTEE REPORT: RESEARCH NEEDS FOR THE TREATMENT OF IRON AND MANGANESE,**
R. B. Robinson, F. J. Dart, K. Pisarczyk, P. C. Singer, and W. Sung.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 9, p 119-122, September 1987. 36 ref.

Descriptors: *Iron, *Manganese, *Water treatment, *Research priorities, Metals, Water quality, Water pollution control, Oxidation, Precipitation, Adsorption, Sequestration.

Iron (Fe) and manganese (Mn) problems affect far more water systems than almost any other water quality concern. The research needed to expand the understanding of the science and technology of these metals is discussed. The oxidation-precipitation and adsorption-oxidation techniques for Fe and Mn control were emphasized since they are the most common approaches used by utilities and because of emerging Fe and Mn problems caused by changes in treatment as a result of the trihalomethane regulations. Sequestration was reviewed because of its increasing use, especially by the small water systems which are frequently afflicted by Mn and Fe problems. It is concluded that there

is still much to learn about the chemistry, treatment, and control of iron and manganese and that treatment effectiveness should be improved while treatment costs are reduced. (Wood-PTT)
W88-05388

**SELECTIVE CHLORINE DETERMINATION BY GAS-DIFFUSION FLOW INJECTION ANALYSIS WITH CHEMILUMINESCENT DETECTION,**
Miami Univ., Oxford, OH. Dept. of Chemistry.
J. R. Gord, G. Gordon, and G. E. Pacey.
Analytical Chemistry ANCHAM, Vol. 60, No. 1, p 2-4, January 1, 1988. 3 fig, 27 ref.

Descriptors: *Chlorine determination, *Chlorine, *Measuring instruments, *Data acquisition, *Flow injection analysis, Chemiluminescence, Free chlorine, Detection limits, Membranes.

The advantages of flow injection analysis (FIA) were applied to develop a sensitive and selective method for the automated routine determination of free chlorine (Cl2/HOCl/OCl(-)) in aqueous systems. The reaction of hypochlorite ion with lophine generates chemiluminescence, which is measured by using a specially designed flow-through detector. This scheme delivers high sensitivity and a detection limit of approximately 75 micrograms/liter as Cl2. Incorporation of a gas-diffusion membrane into the FIA manifold eliminates interference from ionic species, including transition metals, chloride ion, chlorite ion, and chlorate ion. (Author's abstract)
W88-05390

**BACTERIAL LEVELS IN CISTERN WATER SYSTEMS OF NORTHERN KENTUCKY,**
Northern Kentucky Univ., Highland Heights. Dept. of Biological Sciences.
D. J. Lye.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1063-1068, December 1987. 4 tab, 14 ref.

Descriptors: *Bacteria, *Cisterns, *Water storage, *Water quality, *Bacterial analysis, Coliforms, Heterotrophic bacteria, Kentucky, Water tanks, Storage tanks, Drinking water, Rural areas, Water quality standards, Water sampling.

In rural Northern Kentucky, rainwater is commonly collected from rooftops and stored in cement block cisterns as the sole source of drinking water. Although every cistern system is unique in some aspect of design, use, or maintenance, a bacterial survey of 30 rural Northern Kentucky cistern systems suggests that coliforms and heterotrophic bacteria are common to all types of cistern storage systems. An average of 600 coliforms/milliliter and 360,000 heterotrophic bacteria/milliliter were detected in water samples from the bottoms of the cistern storage tanks. Bacterial levels in water delivered to household cold water faucets were similar to the levels found in the storage tanks. When detected, fecal coliforms were recovered throughout the entire system including the household cold tap faucet. Current U.S. regulations for drinking water quality are discussed, with a suggestion that fecal coliform levels may be more appropriate guidelines for interpreting the water quality of individually maintained, non-chlorinated, non-piped water supplies, such as cistern storage systems. (Author's abstract)
W88-05408

**KEY ISSUES OF THE DRINKING WATER AMENDMENTS,**
For primary bibliographic entry see Field 6E.
W88-05430

**EXAMINATION AND CHARACTERIZATION OF DISTRIBUTION SYSTEM BIOFILMS,**
American Water Works Service Co., Inc., Belleville, IL. Belleville Lab.
M. W. LeChevallier, T. M. Babcock, and R. G. Lee.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 12, p 2714-2724, December 1987. 10 fig, 5 tab, 48 ref.

Descriptors: *Water distribution, *Water treatment, *Water analysis, *Biofilms, *Bacterial analysis, *Water mains, Coliforms, Species diversity, Organic carbon, Bioindicators, Indicators, Pipelines, Disinfection, Flushing, Water quality, Chlorine residual.

Investigations concerning the role of distribution system biofilms on water quality were conducted at a drinking water utility in New Jersey. The utility experienced long-term bacteriological problems in the distribution system, while treatment plant effluents were uniformly negative for coliform bacteria. Results of a monitoring program showed increased coliform levels as the water moved from the treatment plant through the distribution system. Increased coliform densities could not be accounted for by growth of the cells in the water column alone. Identification of coliform bacteria showed that species diversity increased as water flowed through the study area. All materials in the distribution system had high densities of heterotrophic plate count bacteria, while high levels of coliforms were detected only in iron tubercles. Coliform bacteria with the same biochemical profile were found both in distribution system biofilms and in the water column. Assimilable organic carbon determinations showed that carbon levels declined as water flowed through the study area. Maintenance of a 1.0 mg/liter free chlorine residual was insufficient to control coliform occurrences. Flushing and pigging the study area was not an effective control for coliform occurrences in that section. Coliform bacteria growing in distribution system biofilms may mask the presence of indicator organisms resulting from a true breakdown of treatment barriers. (Author's abstract)
W88-05446

**RECOVERY OF A MARKER STRAIN OF ESCHERICHIA COLI FROM OZONATED WATER BY MEMBRANE FILTRATION,**
Alberta Univ., Edmonton. Dept. of Civil Engineering.
G. R. Finch, M. E. Stiles, and D. W. Smith.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 12, p 2894-2896, December 1987. 4 tab, 13 ref. Alberta Environmental Research Trust grant T0937 and Natural Sciences and Engineering Research Council of Canada grant A1010.

Descriptors: *Pollutant identification, *Water treatment, *Indicators, *Coliforms, *Ozonation, *Membrane processes, *Bacterial analysis, *Bioindicators, *Wastewater analysis, Filtration, Disinfection, Microbiological studies, Culture media, Antibiotics.

Selective and nonselective growth media were evaluated at two incubation temperatures, 35 and 44.5 C, for the recovery of a nalidixic acid-resistant marker strain of Escherichia coli ATCC 11775 by membrane filtration from ozonated 0.05 M phosphate buffer (pH 6.9). There were significantly fewer bacteria recovered with the standard m-FC agar when compared with the same growth medium prepared without bile salts and rosolic acid. This effect was particularly noticeable at the elevated incubation temperature of 44.5 C. These findings are contrary to previous work which concluded that the standard American Public Health Association membrane filtration procedure is suitable for recovery of fecal coliform indicator bacteria from ozonated wastewater. (Author's abstract)
W88-05451

**INACTIVATION OF LEGIONELLA PNEUMOPHILA BY HYPOCHLORITE AND AN ORGANIC CHLORAMINE,**
Auburn Univ., AL. Coll. of Veterinary Medicine.
L. J. Swango, G. R. Wilt, A. D. Killen, E. Williams, and S. D. Worley.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 12, p 2983-2986, December 1987. 2 fig, 3 tab, 24 ref. U. S. Army Medical Research and Development Command and U. S. Air Force Engineering and Services Center contract DAMD17-82-C-2257.

Descriptors: *Water treatment, *Disinfection, *Legionella, *Chlorination, Chloramines, Hypochlorites, Cooling water, Biocides, Bacteria, Water termperature.

The response of Legionella pneumophila to an organic chloramine, designated Compound 1 (3-choro-4,4-dimethyl-2-oxazolidinone); calcium hypochlorite; and a combination of the two chemicals was assessed. Inactivation times (>4 log decrease in CFU/ml) for demand free conditions were 2-5 min for a total Cl concentration of 10 mg/liter using Compound 1; 1 min with calcium hypochlorite. Under high demand conditions the inactivation times for the same Cl concentrations were 10 min for Compound 1 and 2 min for calcium hypochlorite. Four-week storage tests at 4, 25, and 37 C showed that calcium hypochlorite lost its residual chlorine (originally 4.0 mg/liter) at 2 weeks at the higher temperatures, whereas Compound 1 maintained its original residual chlorine concentration for the duration of the test. A 1:1 wt/wt of total chlorine mixture of the two materials maintained the original chlorine residual for 4 weeks at 4 C. The chlorine residuals in the mixture were 50% of the original 4.0 mg/liter after 4 weeks storage at 25 C; and <50% after 4 weeks storage at 37 C. Compound 1 had superior stability in solution and showed adequate disinfectant potential over a period of one month of repeated reinoculations of fresh bacteria. The mixture of Compound 1 and calcium hypochlorite shows great potential for use as a disinfectant in a closed-cycle cooling water systems. (Cassar-PTT)
W88-05454

**BILLION DOLLAR BABY: 100 PCS WATCH OVER TREATMENT PLANT,**
Municipality of Metropolitan Seattle, WA.
W. E. Nitz.
WATER/Engineering and Management WENMD2, Vol. 135, No. 2, p 36-37, February 1988.

Descriptors: *Computers, *Programmable controllers, *Water treatment facilities, *Control systems, *Network design, *Automation, Telemetry, Seattle.

In 1984, Metro Seattle embarked on a system-wide construction program to enlarge and upgrade its facilities. Included in the billion dollar program are plans for replacement of older control systems, such as computer augmented treatment and disposal (CATAD), and for installation of entirely new systems. Programmable controllers (PCs) will replace existing remote telemetry units and older analog controllers. Equipment selection criteria, vendor selection, controlling the process, and networking the controller are discussed. Metro's decision to buy expanded capability at this time allows them to: easily plan future control scenarios; freely select from a host of computer manufacturers; and easily integrate new equipment. (Ver-Nooy-PTT)
W88-05472

**PIPE-LINING A PIPELINE,**
Hart Crowser, Inc., Anchorage, AK.
For primary bibliographic entry see Field 8G.
W88-05483

**OZONING THE AQUEDUCT,**
Los Angeles City Dept. of Water and Power, CA.
D. G. McBride, and G. F. Stolarik.
Civil Engineering CEWRA9, Vol. 57, No. 12, p 81-83, December 1987. 1 fig, 1 tab.

Descriptors: *Water treatment, *Ozonation, *Disinfection, *Aqueducts, Los Angeles Aqueduct, Filtration, Giardia.

Sierra Nevada snowmelt undergoes a 30-min treatment at the Los Angeles Aqueduct Filtration Plant. The treatment steps are ozone contacting, flash mixing of coagulants, particulate agglomeration, and gravity filtration. Ozone is supplied by five ozonators that partially convert oxygen from an on-site cryogenic separation plant. Ozonation is

desirable for pathogens such as Giardia lamblia cysts, which are resistant to chlorination at lower doses. Ozone's oxidation of organic matter helps produce a strong, sticky floc that is easily trapped in the subsequent deep filtration step. The deep-bed filters are designed for a very rapid filtration rate 13.5 gpm/sq ft. The coarse-grained coal medium is 6 ft deep. Incorporation of ozonation into the design reduced the capital costs from $74.9 million to $73.0 million. (Cassar-PTT)
W88-05485

**WATER FOR ALL-WHO PAYS,**
World Health Organization, Geneva (Switzterland). Community Water Supply and Sanitation Unit.
For primary bibliographic entry see Field 6C.
W88-05493

**FIELD EVALUATION OF CONTROLLED RELEASE COPPER GLASS AS A MOLLUSCICIDE IN SNAIL CONTROL,**
Blair Research Lab., Harare (Zimbabwe).
S. K. Chandiwana, J. Ndamba, O. Makura, and P. Taylor.
Transactions of the Royal Society of Tropical Medicine and Hygiene TRSTAZ, Vol. 81, No. 6, p 952-955, November/December 1987. 1 fig, 3 tab, 12 ref.

Descriptors: *Molluscicides, *Copper controlled release glass, *Snails, *Water pollution effects, *Pesticide toxicity, *Field tests, *Streams, Pesticides, Mollusks, Zimbabwe, Frogs, Fish, Sediments, Seasonal variation, Flow rates.

Limited field evaluation of a new molluscicide, copper controlled release glass (CRG), was carried out in 4 human contact sites in shallow and slow flowing streams in the highveld region of Zimbabwe during 1984 to 1986. The results indicate that the copper CRG has great potential as an inexpensive snail control agent to reduce schistosomiasis transmission. There was a marked reduction in snail numbers in the treated sites after application of 2 forms of the copper molluscicide; a 'fast' CRG with approximately 24-hour solution time in water and a 'slow' CRG with about 1-year solution time. Snail numbers remained depressed during the observation period while frogs and fish were not affected. Fluctuations in snail numbers in the untreated sites showed no clear pattern, being erratic and unpredictable and probably attributable to seasonal effects. Problems of the correct amounts of molluscicide to apply to a site are to an extent overcome by knowledge of the copper binding capacity of the mud substrate. The mud sediment can be saturated by the 'fast' release copper glass to achieve a snail killing concentration in the water which can be sustained by the 'slow' release glass. It appears that the main difficulty in maintaining desirable copper levels in the water is flow, which causes rapid removal of copper from the treated waterbody. Thus, under field conditions on the highveld region of Zimbabwe, the CRG molluscicide is likely to be effective only during the stable conditions of the dry season which is, however, the main transmission period. (Author's abstract)
W88-05494

**DEVELOPMENTAL TOXICITY OF HALOGENATED ACETONITRILES: DRINKING WATER BY-PRODUCTS OF CHLORINE DISINFECTION,**
Health Effects Research Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5C.
W88-05497

**MODELING SOLUTE TRANSPORT USING QUICK SCHEME,**
Bradford Univ. (England). Dept. of Civil Engineering and Structural Engineering.
R. A. Falconer, and S. Liu.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 3-20, February 1988. 11 fig, 20 ref.

Descriptors: *Chlorination, *Solute transport, *Chlorine contact tanks, *Mathematical models, *Model studies, *Water treatment, Comparison studies, Velocity distribution, Model testing, Spatial distribution, Distribution patterns, Prediction, Hydraulic structures, Basins, Advection, Finite difference methods, Mathematical studies, Mathematical equations.

Details are given of the refinement and application of a two-dimensional depth integrated numerical model to predict the depth mean velocity field and the spatial concentration distribution in hydraulic basins, such as chlorine contact tanks. The model includes a refined and computationally manageable third-order spatial finite-difference representation of the terms describing the advective transport of a solute, with the corresponding difference scheme being particularly suited to modeling high solute gradients. The scheme is shown to yield high accuracy in comparison with the more conventional second-order central-difference representation, with the associated spurious wave-type distribution solute concentrations associated with high-solute gradients being considerably reduced. The model was applied to a laboratory hydraulic model study of plug flow through a site-specific chlorine contact tank, with the numerical model results for various tank configurations being compared with corresponding laboratory model results. In most cases the numerical model predictions of the flow through curves for a conservative tracer were in close agreement with the corresponding laboratory model results, particularly in comparison with the predictions obtained using a central-difference representation. (Author's abstract)
W88-05507

**CHEMISTRY AND FATE OF AL(III) IN TREATED DRINKING WATER,**
Syracuse Univ., NY. Dept. of Civil Engineering.
C. T. Driscoll, and R. D. Letterman.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 21-37, February 1988. 6 fig, 3 tab, 27 ref, append.

Descriptors: *Aluminum, *Drinking water, *Fate of pollutants, *Water treatment, *Path of pollutants, Alum, Solute transport, Water distribution, Chemical reactions, Fluoridation, Chemical treatment, Temperature effects, Water temperature, Seasonal variation, Speciation.

In order to better understand the processes that affect the chemistry and transport of residual Al, solutions were monitored prior to and following water treatment. The use of alum increased the total Al concentration from 0.37 plus or minus 0.33 micromoles/liter (umol/L) in raw water to 1.8 plus or minus 0.33 umol/L in filtered water. Approximately 11% of the Al input (raw water and alum) was not retained during treatment, and this residual Al was conservatively transported throughout the distribution system. The treated water contained only a small amount (0.26 plus or minus 0.26 umol/L) of particulate Al. Of the remaining Al (1.5 plus or minus 0.33 umol/L), 29% was associated with organic matter (0.44 plus or minus 0.30 umol/L), 52% was present as monomeric aluminohydroxide complexes (0.81 plus or minus 0.37 umol/L), and 19% was complexed with F (0.30 plus or minus 0.15 umol/L). Results indicate that chemical addition associated with water treatment (eg., fluoridation, H2SO4 addition) and seasonal variations in water temperature were largely responsible for changes in the speciation of Al. (Author's abstract)
W88-05508

**CALIBRATING WATER DISTRIBUTION NETWORK MODELS,**
Visvesvaraya Regional Coll. of Engineering, Nagpur (India). Dept. of Civil Engineering.
P. R. Bhave.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 120-136, February 1988. 2 fig, 3 tab, 19 ref.

Descriptors: *Water distribution, *Model calibration, *Model testing, *Evaluation, *Nodal demands, *Pipe resistance, Water conveyance, Calibrations, Model studies, Mathematical equations, Expansion, Planning, Loading conditions, Water demand, Prediction, Pipes.

Calibration of water distribution network models is necessary in predicting their behavior under different loading conditions or in planning their expansions. Of the several data used in calibration, the predicted nodal demands and the pipe resistance coefficients are the least reliable. The model user usually adjusts the pipe resistance coefficients and/or the nodal demands by trial-and-error procedure and achieves calibration by making the predicted nodal pressures reasonably agree with the observed nodal pressures. A systematic iterative calibration procedure that decides the required adjustments in the nodal demands and pipe resistance coefficients is developed. The procedure is also illustrated through an example network. (Author's abstract)
W88-05514

**EFFECTS OF SMP ON BIOFILM-REACTOR PERFORMANCE,**
Procter and Gamble Co., Cincinnati, OH. Ivorydale Technical Center.
For primary bibliographic entry see Field 5D.
W88-05520

**ANTILUNG CANCER ACTIVITIES OF SELENIUM,**
Pittsburgh Univ., PA. Graduate School of Public Health.
J. H. Lange, E. O. Talbott, K. M. Baffone, D. A. Weyel, and E. G. Soboslay.
Medical Hypotheses MEHYDY, Vol. 23, No. 4, p 443-447, August 1987. 23 ref.

Descriptors: *Selenium, *Lung cancer, *Human diseases, *Disease prevention, *Drinking water, Diseases, Trace elements, Metabolites, Metals, Supplemental selenium, Water supply.

Selenium is considered an essential trace element in most animal and plant species, although still reported in many texts as a highly toxic material. Epidemiological investigations have reported an inverse relationship between selenium and lung cancer. Explanations of reported observations have resulted in numerous mechanistic theories. Only recently have selenium metabolites involved in excretion been considered potential agents for antilung cancer activity. Anticancer properties have been shown in occupationally exposed copper smelter workers, dietary investigations and experimental studies. Supplementation with selenium of public water supplies, as is currently done with fluoride, is a potential method for increasing blood concentration. This may permit development of a population prevention strategy against lung cancer and other diseases. (Author's abstract)
W88-05544

**SOFTWARE TO MATCH DISTRIBUTION SYSTEM'S NEEDS,**
Greeley and Hansen, Chicago, IL.
For primary bibliographic entry see Field 7A.
W88-05554

**SOLVING A GIARDIA PROBLEM IN A SMALL TREATMENT SYSTEM,**
Woodard and Curran, Inc., Portland, ME.
M. R. Albert, S. J. Quail, and R. A. Kruse.
Water Engineering and Management WENMD2, Vol. 134, No. 10, p 23-25, October 1987. 4 fig.

Descriptors: *Giardiasis, *Water treatment, Chlorination, Montana, Protozoa, Human disease, Surface water, Turbidity, Water delivery, Construction costs, Network design, Water treatment facilities.

Outbreaks of Giardiasis continue to occur, despite the availability of water treatment technology that can remove the cysts. Many of these outbreaks occur in small, rural communities that rely on surface water sources and that use basic water treatment facilities to produce potable water. In 1980, an outbreak of Giardiasis affected nearly half the residents of Red Lodge, Montana, a small resort community. The existing water system consisted of a gravity supply, surface water intake

about 300 ft above the city, and a chlorinator feeding water directly into the distribution system through two miles of transmission line. Neither system storage nor individual water meters existed. A master plan was developed whose objectives were to supply treated water free from Giardia cysts, reduce distribution system pressures, provide storage, and install meters to apportion costs. These objectives were achieved by adding a new treatment plant; dividing the distribution system into two pressure zones, each regulated by storage reservoirs; and installing water meters on all services. Start-up of the new facility was accomplished in 1984, and it has performed well without mechanical problems. The plant has met the 0.10 NTU criteria for finished water turbidity over 98 percent of the time over an 809-day data-gathering period. Construction costs were $1.2 million and annual costs for chemicals, power, and labor are $34,216. (Shidler-PTT)
W88-05555

**FINDING TREATMENT OPTIONS FOR INORGANICS,**
CWC-HDR, Inc., Edmonds, WA.
B. R. Willey.
Water Engineering and Management WENMD2, Vol. 134, No. 10, p 28-31, October 1987. 2 tab, 2 ref.

Descriptors: *Legislation, *Water treatment, *Inorganic pollutants, Groundwater, Arsenic, Asbestos, Barium, Cadmium, Chromium, Copper, Fluorides, Lead, Mercury, Nitrates, Nitrites, Selenium, Silver, Costs.

The 1986 amendments to the Safe Drinking Water Act require the regulation of 83 contaminants by 1989 and an additional 25 contaminants every three years thereafter, thus creating a tremendous impact on the water treatment industry. The EPA recently estimated that the annual cost of complying with the amendments will be between $2.5 billion and $4 billion. Compliance will require increased awareness of water supplies and an increased understanding of the approaches available for treating contamination problems. Fortunately, technologies exist for treating all contaminants currently regulated and those expected to be regulated in the near future. With the exception of asbestos, contamination by naturally occurring inorganics is primarily a groundwater problem; consequently, small communities served by well systems face the greatest compliance difficulties for these contaminants. Surface water contamination problems also occasionally occur, typically caused by sources such as industrial discharges. The author reviews and summarizes available treatment technologies for arsenic, asbestos, barium, cadmium, chromium, copper, fluoride, lead, mercury, nitrate, nitrite, selenium, and silver. (Shidler-PTT)
W88-05556

**NON-SANITARY ENGINEERING FEATURES CAN HELP ENSURE A PLANT'S SUCCESS,**
Krishna Engineering Consultants, Inc., West Des Moines, IA.
G. T. K. Krishna.
Water Engineering and Management WENMD2, Vol. 134, No. 10, p 32-37, October 1987. 3 fig.

Descriptors: *Water treatment facilities, *Design criteria, Personnel, Architecture, Ventilation, Plumbing, Heating, Electric power.

Sometimes in the design of a treatment plant project, features not directly related to the process are overlooked; avoiding this can substantially improve a plant's performance. Early involvement of an experienced operator in the design and construction phase for a new treatment plant is recommended. Also discussed are Structural/Architectural, Ventilation, Plumbing, Heating, and Electrical aspects of the working environment. The most often neglected structural/architectural design item is a failure to facilitate proper maintenance and operation, e.g., provision for equipment access and for it to be moved or removed. Energy-conserving ventilation systems which do not compromise removal of hazardous and/or corrosive gases must be provided. Plumbing needs include wash sinks that permit washing of hands up to the elbows, mop sinks to allow washing of legs and boots, emergency eye wash and shower facilities in all areas where chemicals are handled, adequate hot water generation, and acid-resistant drains in laboratories. Heating equipment should be energy-efficient, adequately sized, and integrated with the ventilation system. It is recommended that all critical equipment be fed by a redundant power distribution system; electrical systems must always permit primary treatment and disinfection to continue, allow heating of areas where there is a potential for freezing, permit ventilation of all hazardous areas, and provide egress illumination for safe exit from all structures. (Shidler-PTT)
W88-05557

**SURVEY CHARACTERIZES THE SMALL WATER SYSTEM,**
Alabama Rural Water Association, Montgomery.
J. E. Regnier.
Water Engineering and Management WENMD2, Vol. 134, No. 10, p 38-40, October 1987. 4 fig, 2 tab.

Descriptors: *Water treatment facilities, *Rural areas, *Alabama, *Surveys, Water use, Water distribution, Water supply, Personnel, Water costs, Budgeting, Cost analysis.

With the advent of appropriate legislation in the early 1960's, funding became available to provide 'city water' to many small towns and rural communities. Unfortunately, few guidelines have been available for judging operating practices with the objective of maximizing efficiency. As a first step in providing useful information to the small system manager, the Alabama Rural Water Association conducted a survey of its members in an attempt to develop a true profile of the typical small water supply system. Specific information gathered about each of the survey's 42 respondents included county location; residential and commercial customers; miles of distribution line; supply type--well, surface, purchase, or combination; gallons produced or purchased/year; residential and commercial gallons sold/year; office and maintenance personnel; and annual cost for water, salaries, postage, vehicles, chemicals, utilities, insurance, audits, meter reading, and billing. From the survey responses a profile of a typical rural system was developed; this system has 1500 customers, 137 miles of pipe, 5 employees, purchases its water from other systems at 90 cents per 1000 gallons, has 18 percent unaccounted-for water, and sells 6300 gallons per residential customer. Systems that produce their own water do so at an average cost of 83 cents per 1000 gallons, 75 percent of which cost is for salary, utilities, and supplies. An annual budget of $76,360 was developed for a hypothetical 1000-customer water system. (Shidler-PTT)
W88-05558

**MAKING CHLORINATION TRUSTWORTHY,**
Fischer and Porter, Co., Warminster, PA.
W. H. Nagel.
Water/Engineering and Management WENMD2, Vol. 134, No. 8, p 25-26, August 1987. 6 fig.

Descriptors: *Chlorination, *Residual chlorine, *Monitoring, *Warning systems, Electrical equipment, Process control.

Increased dependability for a chlorination process is easily attainable through the use of one or more monitors to oversee the amount of chlorine introduced into the water, as well as the quantity that remains in the water as residual. To alert operating personnel to the fact that proper and adequate chlorination is no longer being practiced, there are a number of simple--and for the most part inexpensive--safeguards that can be designed into a new chlorination system, or added as a retrofit to existing chlorination systems. Safeguards discussed here include limit switches on electrically driven gas control valves, high- and low-vacuum alarm contacts, a direct current signal, trip switches, and supervision of the incoming electrical signal(s) from a main line water from transmitter. These safeguards may be used to signal the plant personnel through audible or visual signals. (VerNooy-PTT)
W88-05566

**USING OXYGEN TO CONTROL HYDROGEN SULFIDE IN MUNICIPAL WASTEWATER SYSTEMS,**
BOC Group, Inc., Murray Hill, NJ. Airco Industrial Gases Div.
For primary bibliographic entry see Field 5D.
W88-05568

**OXIDATION OF SULFHYDRYL GROUPS BY MONOCHLORAMINE,**
Johns Hopkins Univ., Baltimore, MD. School of Hygiene and Public Health.
J. G. Jacangelo, V. P. Olivieri, and K. Kawata.
Water Research WATRAG, Vol. 21, No. 11, p 1339-1344, November 1987. 4 fig, 1 tab, 19 ref.

Descriptors: *Monochloramine, *Water treatment, *Disinfection, *Bacteria, *Sulfhydryl oxidation, Biocides, Oxidation, Protein oxidation, Proteins, Escherichia coli, Chemical reactions.

In recent years use of monochloramine (NH2Cl) has increased for water disinfection because of its low trihalomethane formation potential. Monochloramine is also the predominant disinfectant upon chlorination of wastewater effluents. In an effort to understand more clearly the disinfectant's mode of action in inactivating microorganisms, the compound's reactions with sulfhydryl (-SH) groups were evaluated. The extent of oxidation of these groups was dependent upon the molar ratio of -SH to NH2Cl. When this ratio was $> 2{:}1$, the reaction was reversible and ceased at disulfide formation. However, at a ratio of $< 21$, the reaction proceeded irreversibly beyond the disulfide; this reaction continued in the presence of monochloramine residual. Not all -SH groups in Escherichia coli B were available for reaction. Masking of these groups within bacterial proteins prevented their complete oxidation at monochloramine doses as high as 100 milligrams/liter. The extent to which sulfhydryls are oxidized in bacteria may play an important role in further research on microbial reactivation. (Author's abstract)
W88-05590

**RELEASE OF BROMINE INTO A CONTINUOUS STREAM OF WATER FROM POLYVINYLPYRIDINE-BROMINE COMPLEX IN PACKED COLUMNS,**
Weizmann Inst. of Science, Rehovoth (Israel).
J. Zabicky, and B. Riegler.
Water Research WATRAG, Vol. 21, No. 11, p 1383-1388, November 1987. 5 fig, 2 tab, 9 ref.

Descriptors: *Bromine, *Water treatment, *Disinfection, *Chemical treatment, Polyvinylpyridine-Bromine complexes, Permeability, Elution rates, Mathematical equations, Algal control, Water quality management, Water quality.

The stability of polyvinylpyridine-bromine complex, its permeability, and the ease with which it can be handled allow its use for disinfection of water stores or algal growth inhibition in water. In experiments to determine bromine release rates, packed columns containing polyvinylpyridine-bromine complex in the bead form were eluted by a continuous stream of water. The permeability of the columns was sufficient to allow maximum rates of elution at relatively low head loss. The rate of bromine elution was studied as a function of time and column length, prior to application of these columns in water disinfection. After an initial period of about 0.5 hours the rate of bromine elution followed an inverse function of time. At any state of column depletion, the rate of bromine supply was proportional to the flowrate at low flows and independent of flowrate at high flows, pointing to different rate determining mechanisms for each flow range. (Wood-PTT)
W88-05596

**PHYSICAL AND COMPUTER MODELS OF MULTIQUALITY NETWORKS,**
Technion - Israel Inst. of Tech., Haifa. Dept. of

Agricultural Engineering.
G. Sinai, G. Shina, E. Kitai, and M. Shah.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 6, p 745-760, November 1987. 12 fig, 15 ref, 1 append.

Descriptors: *Computer models, *Impaired water use, *Model studies, *Irrigation, *Water quality management, *Solute transport, *Pipelines, Structural models, Computers, Irrigation water, Israel, Salinity, Brackish water, Gages, Flowmeters, Hydrodynamics, Flow characteristics, Sensitivity analysis, Water quality control.

A reduced-scale physical model of a multiquality water system was developed. The model is constructed of small-diameter plastic irrigation pipes, simulating the prototype pipeline network, and a computerized data-acquisition system which continuously records signals from pressure transducers, flow-rate gages, and salinity sensors. Similitude analysis was conducted, and the following scale factors were chosen: for pipe length, 0.05; for time, 0.25; for velocity, 0.4; and for pipe diameter, 0.05. A multiquality irrigation network of a farm in Israel was simulated using the reduced-scale physical model and a theoretical computer model developed earlier. Steady-state flow rates and salinities were measured in several locations of that network and were found to agree with the simulated ones. Dynamics of salt front transportation lag and reservoir response are also tested. The dynamic response of the pond to step change in input salinity behave in a similar manner to the simple first-order delay assumed in the theoretical model. Combined use of these two models is suggested for the analysis of multiquality water systems. The physical model is most effectively used for testing physical phenomena and for examination of real control systems. The computer model is more suitable for sensitivity analysis and quick checks. (Author's abstract)
W88-05612

**HIERARCHICAL ALGORITHM FOR WATER SUPPLY EXPANSION,**
Lower Colorado River Authority, Austin, TX. Water Policy and Programs Div.
For primary bibliographic entry see Field 6A.
W88-05641

**UPGRADING FILTRATION TO MEET PENDING STANDARDS: PART II. STRUCTURAL AND EQUIPMENT IMPROVEMENTS,**
Hazen and Sawyer, New York.
G. P. Fulton.
Public Works PUWOAH, Vol. 118, No. 8, p 68-72, August, 1987. 7 fig.

Descriptors: *Filtration, *Water treatment, *Water quality standards, *Drinking water, *Filters, Standards, Detention time, Mixing, Chemical treatment, Baffles, Flocculation, Settling tanks, Maintenance, Process control, Optimization.

Structural and equipment improvements are discussed for upgrading filtration to meet pending standards. These include measures for eliminating short circuiting, which hampers the performance of mixing and settling basins and causes other problems. Flash mixing is used to thoroughly disperse chemicals in the incoming water flow. The design and operation of flash mixers, flocculators, settling tanks, and drinking water filters are discussed. The most important features of flash mixer design include circulation capacity, point of chemical introduction, and detention time. The two most common problems with flocculation include short circuiting of the process flow through flocculator basins and lack of flexibility in energy input applied by mechanical paddles or agitators. Short circuiting of flow-through is also the basic cause of inefficiency in settling tanks. Filtration problems include improper media, backwash systems, surface wash systems, and rate control. Overall planning improvements are suggested, including measures for achieving turbidity standards, cleaning or replacement of filter media, and chemical feed adjustment testing to optimize coagulant feed and solids conditioning. (Doria-PTT)
W88-05651

**STANDARD MODEL DESIGNS FOR RURAL WATER SUPPLIES.**
World Health Organization, Copenhagen (Denmark). Regional Office for Europe.
For primary bibliographic entry see Field 8A.
W88-05702

**DRINKING WATER MICROBIOLOGY.**
Special Issue of the Journal of Environmental Pathology, Toxicology and Oncology, Volume 7, No. 5/6, May-August, 1987. 365 p. Edited by Dean O. Cliver, and Ruth A. Newman.

Descriptors: *Drinking water, *Water treatment, *Water distribution, *Water quality control, *Microbiological studies, Bacteria, Viruses, Protozoa, Fungi, Water quality management, Potable water, Design standards, Public health.

Water for potable use should be taken from the best source available to the community. If the quality of the sources does not meet appropriate criteria and standards for safety, treatment must be developed to protect the public health. From long experience, the effects produced by each of the major water treatment procedures the pathogens present in the water and what effect changes in treatment may have on the indicator systems by which the quality of the water is monitored are known. Few unit processes in water treatment, other than disinfection, have been designed specifically to act upon the microorganisms present in the water. Therefore, reductions of pathogens as a result of these processes are largely fortuitous. No matter how excellent the quality of drinking water may be when the treatment plant is finished, the responsibility of the water utility must extend to safe storage and distribution of water to the service connection at the point where the water is used. Though the principal emphasis in this report is on the effects of water and of drinking water technology upon microorganisms, it is also obvious that some microorganisms are capable of significant effects upon their immediate environment and that these effects must be considered in discussing water treatment and distribution. Problem areas include the degradation of surfaces in contact with drinking water, as a result of organic or inorganic reactions induced by microbes, and the influence of accumulated microbial cells upon the functions of water treatment resins and on the mains through which water is expected to flow. The technological problems which may result from microbial growth during treatment and distribution of public water supplies are part of the task of providing water to the consumer; however, drinking water, in some situations, must be held in a static condition for substantial periods of time. Two such applications are that of supplying drinking water aboard ships and that of packaging drinking water in containers for emergency use or for commercial distribution. Each of these technological problems may appear to lie outside the traditional scope of drinking water microbiology, but are included because they are significant to the task of providing safe, palatable drinking water to the consuming public. (Lantz-PTT)
W88-05707

**COMPUTERS IN THE WATER INDUSTRY: IMPACT ON THE REGULATORY PROCESS,**
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
R. M. Clark.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-203295. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/202, June 1987. 17 p, 9 fig, 3 tab, 9 ref.

Descriptors: *Water quality control, *Water treatment, *Computer models, Model studies, Regulations, Toxicity, Drinking water, Coliforms, Case studies.

The Environmental Protection Agency's (EPA) Drinking Water Research Division (DWRD) is responsible for evaluating the various types of treatment technologies that might be considered for meeting the Maximum Contaminant Levels (MCLs). The traditional approach is to evaluate the kinetics of a process at the bench-scale, study it at the pilot plant scale, and then evaluate cost and performance of a treatment technology at the field scale whenever possible. Although this traditional approach is dependable it is also time consuming. Because of the accelerated time frame for regulation along with the increased number of contaminants to be regulated using such a deliberate protocol is not possible. Therefore, the DWRD has increasingly turned to computer modeling and simulation as a means of providing support for the technology evaluation process. This study concentrates on the use of modeling in evaluating drinking water technology. Modeling has both benefits and shortcomings which have implications for the regulated drinking water utilities and the implementors of regulations including States and the EPA. Three examples of modeling are presented which are explored in some detail. One example, a toxic screening model for surface water sources has been completed with positive results. A second example, a compliance study dealing with coliform in surface waters has led to confusing and potentially misleading conclusions. The third example, a technology evaluation model, is underway and will have significance for the water supply industry. A brief review of DWRD's overall modeling activities is also presented. (Lantz-PTT)
W88-05711

**SURVIVAL AND VIRULENCE OF WATERBORNE PATHOGENIC BACTERIA IN POTABLE WATERS,**
Montana State Univ., Bozeman. Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W88-05732

**BIOLOGY OF GALLIONELLA,**
Goeteborg Univ. (Sweden). Dept. of Marine Microbiology.
For primary bibliographic entry see Field 5B.
W88-05733

**BIOLOGY OF LEPTOTHRIX, GALLIONELLA, AND CRENOTHRIX: RELATIONSHIP TO PLUGGING,**
Cornell Univ., Ithaca, NY. Dept. of Microbiology.
For primary bibliographic entry see Field 2F.
W88-05734

**GROUND WATER BIOGEOCHEMISTRY OF IRON AND MANGANESE IN RELATION TO WELL WATER QUALITY,**
Helsinki Univ. (Finland). Dept. of Geology.
For primary bibliographic entry see Field 2F.
W88-05740

**COST AND PERFORMANCE EVALUATION FOR FULL SCALE, SINGLE SOLUTE CONTROL OF SYNTHETIC ORGANIC CHEMICALS BY GRANULAR ACTIVATED CARBON ADSORPTION,**
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
J. Q. Adams, R. M. Clark, and R. J. Miltner.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB87-202925. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/205, June 1987. 27 p, 15 fig, 4 tab, 3 ref.

Descriptors: *Water treatment, *Acivated carbon, *Water quality control, *Granular activated carbon, *Costs, *Performance evaluation, Organic compounds, Drinking water, Adsorption, Water pollution prevention, Dibromoethane.

The amendments to the Safe Drinking Water Act will require an extensive evaluation of the feasibility for removing organic compounds using granular activated carbon (GAC). In order to meet very short deadlines for technology evaluation, the Drinking Water Research Division has incorporated the use of microcolumn and adsorption modeling combined with cost models to make full scale projections for the performance of GAC systems.

Analysis has been performed on a representative list of compounds. For poorly adsorbed compounds, the minimum cost system is associated with shorter empty bed contact times (EBCTs). However, this must be evaluated case by case, and depends on influent concentration and effluent goals. For some compounds, there may be a range of EBCTs at which cost is near minimum as shown in the 1,2-dibromethane example. All of these compounds have been analyzed as if they were single solutes when in reality they will occur in nature as part of a mixture. However, the analysis presented in this paper should be useful for preliminary planning. (Lantz-PTT)
W88-05754

**EFFECTIVENESS OF COMMERCIALLY AVAILABLE HOME WATER PURIFICATION SYSTEMS FOR REMOVING ORGANIC CONTAMINANTS,**
Dynamac Corp., Panama City, FL.
R. W. Cole.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A181 759. Price codes: A04 in paper copy, A01 in microfiche. Report No. ESL-TR-86-25, September 1986. Final Report. 50 p, 1 fig, 16 tab, 27 ref. Contract No. F08635-85-C-0057.

Descriptors: *Water quality control, *Water treatment, *Activated carbon, *Organic compounds, *Performance evaluation, *Potable water, Domestic water, Filtration, Filters, Drinking water, Carbon filters.

The performance of a home water treatment system (Continental Model 350, Everpure AC4-THM, Aqualux CB-4, Culligan Model SG-2, or Amway) using activated carbon combines the system design, type and amount of carbon, and the amount of time the water is in contact with the carbon. An efficient system will achieve high removal rates, averaging 90% for trihalomethanes and 95% for other halogenated organics, over the filter's lifetime capacity. In addition to its average performance, the removal percentage range over filter life is important, i.e., beginning and ending performance figures. The rated gallonage for each filter should be examined and redefined, if necessary, to achieve high-performance removal rates over filter life. Generally, removal percentages are higher when the filter is first put on line and drops as the rated capacity is reached. The degree of reduction will separate a good filter from a poor performer. Obviously, a rupture in the filter will cause a sudden drop in performance. Carbon loading is a more reasonable explanation. As the active sites of the carbon become filled, the ratio of the number of available sites to the contaminant concentration decreases, resulting in a decrease in filter performance. With the exception of the Culligan unit, the recommended filters exhibited excellent performance over the filter life. The Culligan unit had an extended rated gallonage of 4,000 which attributed to its slightly decreased performance. Extended lifetime capacities prompt the need for a maximum filter replacement time. A replacement every 6 months would be a practical yet acceptable value. Some manufacturers recommend one a year. One of the inherent dangers with a longer replacement time is the potential for increasing bacterial growth and/or bacterial or chemical unloading. Inevitably these filters will degrade with time and use. The establishment of a maximum time limit, not to exceed rated gallonage, would add an additional margin of safety to their use. (Lantz-PTT)
W88-05756

**TREATMENT OF DRINKING WATER FOR ORGANIC CONTAMINANTS.**
Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. 383 p. Edited by Peter M. Huck and Peter Toft.

Descriptors: *Drinking water, *Water quality control, *Organic compounds, *Water treatment, Conferences, Regulations, Potable water, Information exchange.

The proceedings of the Second National Conference on Drinking Water held in Edmonton, Alberta, on April 7th and 8th, 1986, are presented. The theme of the conference was 'Treatment for Organic Contaminants' and the objective was to bring together practitioners, regulatory personnel and researchers concerned with treatment technologies for these contaminants in drinking water. Information on existing and emerging processes used in Canada, the United States and Europe was presented. The conference presented and assessed the state-of-the-art of treatment for organic contaminants and examined possible future directions for Canada. (See W88-05810 thru W88-05830) (Lantz-PTT)
W88-05809

**FEDERAL ACTIVITIES RELATED TO THE TREATMENT OF DRINKING WATER,**
Department of National Health and Welfare, Ottawa (Ontario).
D. Kirkwood.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 1-5.

Descriptors: *Safe Drinking Water Act, *Federal jurisdiction, *Standards, *Activated carbon, *Drinking water, *Water treatment, *Water quality control, Chlorination, Ozonation, Groundwater quality, Organic compounds, Canada, Legislation.

A recent survey conducted by the Department of Health and Welfare in metropolitan centers in Canada showed that some kind of in-home device is used to treat municipal water supplies in about 3% of homes. About half of these devices employ activated carbon filters about which the Department has serious concerns because of the possibility of bacterial growth on the filters. Other classes of devices are not without their drawbacks; those based upon iodine can lead to an excessive intake of this chemical and can affect thyroid activity; ones based on U.V. light may lack monitoring instruments to ensure the proper dose of bactericidal U.V. radiation. The Department has encouraged 'self-regulation' within this industry by working closely with the Canadian Water Quality Association, to which 95% of water treatment device manufacturers belong, in devising a code of practice with respect to device performance and advertising. Indications are that this approach is having only limited success. Most small communities and rural homes in Canada use groundwater as their source of supply. The assumption that groundwater is contaminant free is now in question since organic compounds have been detected in groundwaters at much higher concentrations than those found in surface water supplies. The Department, of course, has always recognized the traditional role of the provinces and municipalities regarding the construction, operation and maintenance of water treatment plants. One of the most widely used treatment chemicals is chlorine which is used as a disinfectant and as an oxidant to degrade organic substances and ammonia. Chlorination gives rise to the formation of chloroform and other trihalomethanes and additional chlorinated by-products many of which may be toxic under certain conditions. A look at alternative disinfectants, however, suggests that the well-proven chlorination process should not be abandoned, since there is very limited knowledge about the alternatives. Canada has no national drinking water standards mandated by, or enforceable through, legislation. There is increasing pressure, however, from the environmental lobby and Boards of Health for legally enforceable standards for drinking water quality. Cabinet ministers will soon discuss the need to introduce new legislation on this matter. It is too early to say what such legislation might contain, but it should be recognized that this alone will not ensure the supply of clean, safe drinking water. (See also W88-05809) (Lantz-PTT)
W88-05810

**GUIDELINES FOR CANADIAN DRINKING WATER QUALITY,**
Department of National Health and Welfare, Ottawa (Ontario).
P. Toft.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 7-16, 5 tab, 13 ref.

Descriptors: *Water treatment, *Canada, *Drinking water, *Water quality control, *Standards, Water quality management, *Organic compounds, Pesticides, Regulations, Benzene, Phenols, Dioxins, Carcinogens.

In Canada, both federal and provincial governments have responsibilities related to drinking water. In general, provincial governments are responsible for an adequate, safe supply, whereas the federal Department of National Health and Welfare develops quality guidelines and conducts research. The Guidelines for Canadian Drinking Water Quality were published in 1978 and include maximum acceptable concentrations for 21 organic chemicals of health concern, 16 of which are pesticides. These guidelines are now in the process of revisions, again through a federal-provincial mechanism. Emphasis is being placed on organic contaminants. In addition to re-evaluating the guidelines for phenols, pesticides, and trihalomethanes, the need for guidelines for a variety of other organic substances is being considered. These include benzene, and alkylated derivatives, chlorobenzenes, chlorinated ethylenes, dichloromethane, chlorinated ethanes, carbon tetrachloride, dioxins, and benzo(a)pyrene. It is also intended that the list of pesticides for which maximum acceptable levels are specified should be updated to reflect current usage. Guidelines are now being developed for 41 pesticides, with an approach similar to that being used for deriving the original 1978 guidelines. However, more of the chemicals now under consideration are being dealt with as carcinogens than was the case in 1978. (See also W88-05809) (Lantz-PTT)
W88-05811

**DEVELOPMENT OF DRINKING WATER REGULATIONS FOR ORGANIC CONTAMINANTS IN THE UNITED STATES,**
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
C. Vogt, J. Cotruvo, and S. Goldhaber.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 17-28, 7 tab, 7 ref.

Descriptors: *Drinking water, *Water treatment, *Regulations, *Water quality control, *Safe Drinking Water Act, *Organic compounds, Standards, Inorganic compounds, Polychlorinated biphenyls, United States, Synthetic organic compounds, Monitoring, Water quality management, Public health.

Comprehensive regulations are being developed to limit human exposure to contamination in drinking water by the U.S. EPA under the authority of the Safe Drinking Water Act. These regulations are being developed in several phases and will include synthetic organic chemicals, inorganic chemicals, microbiological contaminants and radionuclides. This paper addresses synthetic organic chemicals (SOCs) including volatile organic chemicals (e.g., trichloroethylene), pesticides, and other SOCs such as PCBs or trihalomethanes. The regulatory and scientific basis for proposed and final regulations are discussed including: (1) occurrence in drinking water and human exposure; (2) human health risks; (3) analytical methods and monitoring; and (4) treatment and costs of control. (See also W88-05809) (Author's abstract)
W88-05812

**ORGANIC CONTAMINANTS IN DRINKING WATER: WHAT, WHERE, WHEN AND HOW,**
Ontario Ministry of the Environment, Toronto. Water Resources Branch.
For primary bibliographic entry see Field 5G.
W88-05813

**USE OF OZONE AND GRANULAR ACTIVATED CARBON IN DRINKING WATER TREATMENT,**

Karlsruhe Univ. (Germany, F.R.). Engler-Bunte Inst.
H. Sontheimer, and C. Hubele.

IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 45-66, 21 fig, 4 tab, 21 ref.

Descriptors: *Ozonation, *Activated carbon, *Filtration, *Drinking water, *Disinfection, *Water treatment, *Water quality control, Ozone, Biomass, Model studies, Trihalomethanes, Germany, Pilot plants, Biodegradation, Bacterial growth.

Since its first application about 30 years ago, the process combination ozonation/granular activated carbon filtration has become an important treatment step in German water works, especially, when the importance of biodegradation was recognized. Detailed studies at the Mulheim water works have shown that good drinking water quality can be obtained from polluted surface water without high chlorine doses. Exhaustive research work with pilot plants during the last years has provided more information on the interaction of adsorption and biodegradation. Model calculations using the Film-Biofilm-Homogeneous Diffusion model have shown the importance of sequential biodegradation of rapidly and slowly degradable substances within the filters, as well as of biomass displacement. The Film-Homogeneous-Diffusion model and an equilibrium model can, based on adsorption equilibrium data, be applied for the optimization of the process. The analysis of bacterial growth rates allows the characterization of substrates and the assessment of possible regrowth in the water distribution system. The data confirm that breakpoint chlorination, as an important treatment step for surface water, can be replaced by the process combination ozone/granular activated carbon filter or ozone/ground filtration. This usually prevents trihalomethane and TOX formation, resulting in a much better drinking water quality than the classical processes which include breakpoint chlorination. (See also W88-05809) (Lantz-PTT)
W88-05814

**OPERATION OF FULL-SCALE GRANULAR ACTIVATED CARBON CONTACTORS FOR REMOVAL OF ORGANICS,**

Buffalo Pound Water Treatment Plant, Regina (Saskatchewan).
L. Gammie, and G. Giesbrecht.

IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 67-86, 15 fig, 5 tab, 24 ref.

Descriptors: *Activated carbon, *Organic compounds, *Water treatment, *Water quality control, Tasts, Ordor control, Buffalo Pound Water Treatment, Organic carbon, Trihalomethanes, Algae, Chlorine, Pesticides, Polychlorinated biphenyls, Activated carbon, Nitrogen, Flow rate.

A full-scale post-filtration carbon contactor system was installed at the Buffalo Pound Water Treatment Plant in June, 1985 and was operated successfully during the summer and fall of 1985 for removal of odor, trihalomethanes and total organic carbon. Breakthrough curves, cumulative loadings and carbon exhaustion rates were calculated from the contactor monitoring data. Benefits of the system are: (1) removal of algae tastes and odors for about 100 days and very low level odor breakthrough for an additional 40 days; (2) mean removal of 63% of granular activated carbon (GAC) influent total organic carbon (TOC) over 140 days, with effluent levels below 2 mg/L for the whole period; (3) mean removal of 64% of GAC influent trihalomethane (TTHM) over 140 days, with effluent levels consistently below 40 micrograms/L; (4) better free chlorine residuals in the distribution systems and lower standard plate count bacteria levels; (50 expected protection from a wide range of contaminant spills (pesticides, PCBs, etc.) in the source. Limitations of the system include: (1) breakthrough of TOC, TTHMs is fast and effluent levels would soon reach unacceptable limits if influent levels were high; (2) post-chlorination of GAC effluent water produced minor chlorinous odors; (3) carbon exhaustion rates were higher than expected with the bottom portion of the carbon bed being less effective than top layers; (4) organic nitrogen is not effectively removed by GAC; (5) flow rate has a very noticeable effect on performance; (6) removal efficiencies appear to decrease with bed depth, perhaps related to carbon particle size; and (7) it is difficult to predict parameter breakthroughs with time (not linear with bed depth). (See also W88-05809) (Lantz-PTT)
W88-05815

**OPTIMIZATION OF ORGANIC REMOVAL THROUGH THE WATER TREATMENT PROCESS: SAND REPLACEMENT OR POST-ADSORBER FOR GRANULAR ACTIVATED CARBON FILTRATION,**

Lyonnaise des Eaux, Le Pecq (France). Lab. Central.
M. R. Wiesner, J. J. Rook, and F. Fiessinger.

IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 87-105, 10 fig, 4 tab, 24 ref.

Descriptors: *Water treatment, *Water quality control, *Organic compounds, Mathematical models, Activated carbon, Filtration, Organic carbon, Adsorption, Backwash, Costs, Economic aspects, Model studies.

Mathematical models for headloss development and adsorption of dissolved organics were validated for use in predicting the optimal location of granular activated carbon (GAC) in water treatment; either as a replacement for sand in conventional gravity filters, or after sand filtration in post adsorbers. The combination of two predictive models for filtration and adsorption has proven to be an efficient tool in assessing GAC treatment. At a given filtration rate, backwash frequency will be most sensitive to particle concentration at the low concentrations encountered in settled and filtered waters. Even relatively infrequent backwashing will tend to disrupt the adsorption front in a filter. In choosing between first stage versus second stage GAC filtration, this work suggests the following: (1) when total organic carbon removals by adsorption of <40% are sufficient, first stage GAC filtration will provide adsorptive capacity which is at least as good as that of a post-adsorber; (2) where higher removals are desired, post-adsorbers may present certain technical advantages. Their design may provide for better adsorption conditions with longer contact time, undisturbed adsorption front and a smaller diameter; (3) where second stage contactors are provided for, the time between backwashes should be about the same as the time to GAC regeneration; (4) backwashing of second stage contactors such as is required for the control of undesirable biological growth, may eliminate the technical advantage of second stage GAC filtration; and (5) the cost effectiveness of second stage filters will depend on their ability to offset additional capital costs through more efficient use of GAC capacity. (See also W88-05809) (Lantz-PTT)
W88-05816

**OXIDATION BYPRODUCTS FROM DRINKING WATER TREATMENT,**

Rice International Consulting Enterprises, Aston, MD.
R. G. Rice, and M. Gomez-Taylor.

IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 107-133, 4 tab, 72 ref.

Descriptors: *Oxidation, *Water treatment, *Disinfection, *Byproducts, *Drinking water, *Water quality control, Literature review, Chlorine, Chlorine dioxide, Chloramine, Ozone, Chemical reactions, Nitrites, Chloro-nitrile compounds.

Results are discussed of a detailed literature review of the organic and inorganic by-products that have been identified as being formed in aqueous solution with four of the strong oxidizing/disinfecting agents commonly employed in drinking water treatment. These agents are: chlorine, chlorine dioxide, chloramine, and ozone. Significant findings include the production of similar nonchlorinated organic oxidation products from chlorine, chlorine dioxide and ozone. In addition, all three chlorinous oxidants/disinfectants can produce chlorinated by-products under certain conditions. The presence of chloro-nitrile compounds in drinking waters is thought to arise from reactions of chlorine or chloramine to amine/amide functions in amino acids or proteinaceous materials, followed by dehydrohalogenation. These nitriles could hydrolyze to produce the corresponding chloroacetic acids. It is concluded that to minimize the presence of oxidation by-products in drinking waters, the concentrations of oxidizable organic/inorganic impurities should be lowered before any oxidizing agent is added. (See also W88-05809) (Author's abstract)
W88-05817

**PILOT STUDIES INTO EFFECTS OF DISINFECTION STRATEGIES ON DRINKING WATER QUALITY,**

Glenmore Waterworks Lab., Calgary (Alberta).
E. E. Hargesheimer, G. A. Irvine, A. Badakhshan, and R. T. Seidner.

IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 135-149, 10 fig, 16 ref.

Descriptors: *Pilot plants, *Disinfection, *Drinking water, *Water quality, Ozonation, Chlorination, Organic compounds, Aliphatic hydrocarbons, Phenols, Trichloroacetic acid, Chemical reactions, Base-neutral compounds.

A 15.6 cu m/day design capacity pilot plant (PP) was constructed to compare ozonation followed by postchlorination with two stage chlorination as practiced by the 550,000 cu m/day production capacity City of Calgary Glenmore Water Treatment Plant (GWTP). Design considerations for simulation of full scale treatment conditions in the PP model were implemented. The PP was run continuously in parallel with GWTP for more than one year to compare the efficacy of each treatment with seasonally varying raw water quality. Five specific organic compound groups (base-neutral compounds, phenols, aliphatic hydrocarbon acids, halogenated organic acids and volatile chlorinated compounds) were targeted for comparative analysis. No quantifiable difference in base-neutral compounds or phenols could be distinguished between PP and GWTP finished water. Aliphatic hydrocarbon acid (C6-C20) concentrations in PP finished water exceeded those in GWTP. Of the five specific organic compound groups analyzed in this study, chlorinated acetic acids and total trihalomethanes (TTHMs) proved to be valuable quantitative indices for comparing finished water quality obtained from the two treatment trains. A simple ion exchange method was developed and successfully applied to the analysis of dichloroacetic acid (DCAA) and trichloroacetic acid (TCAA) in postchlorinated finished water. PP and GWTP contained similar levels of DCAA at 6.5 ppb and 7.7 pbb, respectively. However, almost twice as much TCAA was recovered from PP finished water (70.0 ppb) than from GWTP water samples (36.0 ppb). While preozonation increased concentrations of both aliphatic and halogenated acids in PP finished water, TTHMs were lower than those formed in GWTP. TTHMs were quantitated immediately after postchlorination as well as following a 24 hr reaction period under simulated distribution system conditions. The reduction in PP TTHMs was mostly attributed to a 79% reduction in chloroform. The brominated trihalomethanes in PP finished water shoed less overall reduction (39%) as compared to GWTP. (See also W88-05809) (Author's abstract)
W88-05818

PILOT PLANT TREATMENT TECHNIQUES FOR TRIHALOMETHANE PRECURSOR REDUCTION - SOME FINANCIAL IMPLICATIONS,
Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
B. R. McLeod, and E. Davis.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 151-160, 7 fig, 1 tab, 11 ref.

Descriptors: *Pilot plants, *Water treatment, *Water quality control, *Trihalomethanes, *Economic aspects, *Oxidation, Humic acids, Model studies, Costs, Chlorine, Chlorination, Organic matter, Energy, Taste, Odors, Organic matter, Hardness.

Methods are described which were used in a model water treatment plant to try to reduce the trihalomethane precursors in a water that is used for domestic purposes. The water is hard, contains much organic matter which produces tastes and odors, which is usually oxidized using free chlorine chlorination. The treatment is found to produce an unacceptable level of trihalomethanes (THMs) in the finished water. The THM precursors in raw Parkland water are very resistant to accepted reduction methods and do not act in a manner similar to laboratory water composed of humic acid in distilled water. The only method investigated in the laboratory which resulted in a significant reduction of THMs, and which produced a satisfactory appearing water was the hydrogen peroxide ultraviolet radiation method. This method just barely satisfied the criterion of the evaluation that the cost of the treated water would not be increased two fold due to chemical costs alone. No efforts were made in the laboratory to minimize electrical energy costs for any of the methods investigated. If a cost of water multiplying factor (similar to the two-fold price increase limit utilized for chemical costs) was established and applied for the actual electrical energy costs involved, it is reasonable to expect that the overall least expensive treatment method would be one of those that incorporated chemical application alone, and which did not require substantial energy input as a part of the treatment method. Methods other than precursor removal must be investigated in order to ensure that treated Parkland water meets existing and future THM requirements. (See also W88-05809) (Lantz-PTT)
W88-05819

REDUCTION OF THE HYGIENICALLY DOUBTFUL CHLORINE COMPOUNDS WITH OZONE, CHLORINE AND CHLORINE DIOXIDE,
Eidgenoessische Technische Hochschule, Zurich (Switzerland).
M. Schalekamp.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 161-184, 78 fig, 31 ref.

Descriptors: *Reduction, *Chlorine, *Ozone, *Chlorine dioxide, *Water quality control, *Water treatment, Drinking water, Chlorite, Public health, Trihalomethane, Chlorate, Toxins.

With the advance of analytical techniques for trace organics, the presence of chloroform and other trihalomethane compounds in treated drinking water following chlorination was established in 1974. In 1975, an article in EPA-Report No. 906 established the carcinogenicity of some of these chlorinated compounds. The outcome of this report was the coming into force of various regulations for drinking water. Today the Rhine River, for example, with the world's largest industrial potential in its catchment area, exhibits essentially fewer trihalomethanes in its raw water than does treated drinking water prepared from just this raw water. Therefore, along with the denouncing of chlorination as a treatment step, other disinfection alternatives were sought. If chlorine dioxide is used in place of chlorine, no chlorinated hydrocarbons are created during the oxidation of organic compounds. However, it has been shown that with chlorine dioxide other, unwanted substances are formed, such as large amounts of chlorite. This substance is, as with nitrite, a producer of methemoglobine which can lead to 'Blue Babies' symptoms in infants. After further treatment of the water with ozone, the chlorite is oxidized to chlorate. At the present time, there are no binding legal limits for chlorate. In contrast to the trihalomethanes, it is not carcinogenic. However, chlorate also seems to be suspect toxicologically and its formation should be prevented as much as possible. (See also W88-05809) (Lantz-PTT)
W88-05820

INVESTIGATIONS ON THE INFLUENCE OF ALGAL-DERIVED ORGANIC SUBSTANCES ON FLOCCULATION AND FILTRATION,
Wahnbachtalsperrenverband, Siegburg (Germany, F.R.).
H. Bernhardt, O. Hoyer, B. Lusse, and H. Schell.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 185-216, 15 fig, 4 tab, 60 ref.

Descriptors: *Algae, *Water treatment, *Organic matter, *Flocculation, *Filtration, Organic carbon, Hydrogen ion concentration, Chemical analysis, Anions, Chemical reactions, Iron, Calcium, Chemical bonds, Turbidity.

Algogenic organic matter (EOM), particularly acidic higher molecular polymers with vicinal hydroxyl and carboxyl groups, influences flocculation with trivalent metal oxide hydroxides depending on the pH. At low concentrations (< or = 1 mg/DOC) these substances can behave like anionic flocculation aids depending on the surface concentrations of the particulate, disperse substances. At higher concentrations, destabilization and aggregation of flocs is impaired due to the formation of surface and mixed ligand complexes with the trivalent metal oxide hydroxides. With Fe:DOC concentration ratios > 3, the disturbance can be compensated to different extents according to the structure of the EOM. The mechanism by which low concentrations of organic matter improve flocculation can be explained by its attachment to the surface of the quartz particles by means of hydrogen and covalent bonds, thereby favoring the agglomeration of the quartz particles already destabilized by polynuclear hydroxo complexes. The agglomeration could occur according to the electrostatic patch model and is substantially helped by the algogenic organic matter, which behaves like an anionic polyelectrolyte forming bridges between the particles. In the presence of higher concentrations of EOM (>1-2 mg/L c in the presence of 5 mg/L Fe as flocculant), surface and mixed ligand complexes are formed between the dissolved polymer anions and the positively charged iron hydroxo complexes and iron oxide hydroxides being formed after addition of the ferric salt. This reaction inhibits or prevents the destabilization of the quartz particles. These complexes are colloidal and they break through the filter and increase the turbidity and residual Fe content of the filtrate. A technically feasible countermeasure which can be taken to prevent the flocculation disturbance is, among other measures, the addition of Ca(2+) ions before flocculation. (See also W88-05809) (Lantz-PTT)
W88-05821

NOVA SCOTIA EXPERIENCE WITH VOLATILE ORGANIC CONTAMINANTS IN DRINKING WATER,
Nova Scotia Dept. of Health, Halifax. Div. of Public Health Engineering.
P. J. Casey.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 217-223, 5 fig, 1 ref.

Descriptors: *Nova Scotia, *Organic compounds, *Chlorination, *Volatile organics, *Drinking water, *Water quality control, *Water treatment, Trihalomethanes, Polychlorinated biphenyls, Monitoring, Water supply, Aeration.

A short history of the concern with and discovery of organic contaminants in Nova Scotia (Canada) public water supplies illustrates that trihalomethanes (THMs) were of first concern (lae 70'3) and were discovered in varying concentrations in all surface water supplies. Direct contamination with volatile organic compounds (VOCs) was then discovered in a groundwater supply (Amherst) as a result of apprehension over PCBs. Province-wide monitoring turned up VOCs in two more supplies. Problems were encountered in analyzing for both THMs and VOCs initially, but were overcome. No action has been taken to alleviate the THM problem to date since all supplies are below the current maximum acceptable concentrations, but regular monitoring is being maintained. A cooperative investigation with the Public Service Commission of Halifax, of treatment plant modifications that may be possible to minimize the occurrence of THMs, is currently underway. The findings to date indicate that the reduction or elimination of pre-chlorination reduces THM formation considerably and that there is a large seasonal variation in haloform concentration. Unfortunately, it is not possible to eliminate pre-chlorination for very long at this plant without the formation of slime on the filters. Measures to deal with VOCs varied from disconnecting wells from the system, aeration of a storage tank, to laboratory evaluation of home removal methods. (See also W88-05809) (Lantz-PTT)
W88-05822

EFFECTIVENESS OF AIR STRIPPING VERSUS ACTIVATED CARBON FOR REMOVAL OF SELECTED ORGANIC CONTAMINANTS AT ULTRA LOW LEVELS,
GMP Associates, Inc., Honolulu, HI.
P. B. Melnyk, W. A. Guirguis, L. A. Mansfield, and K. Hayashida.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 225-239, 5 fig, 7 tab, 4 ref.

Descriptors: *Costs, *Adsorption, *Air stripping, *Activated carbon, *Organic compounds, *Water treatment, Ethylenedibromide, Trichloropropane, Dibromochloropropane, Well water, Water quality, Pilot plants, Economic aspects, Performance evaluation.

Laboratory and pilot plant tests were conducted to determine the effectiveness of air stripping versus adsorption with activated carbon in removing combinations of ethylene dibromide (EDB) and trichloropropane (TCP) or dibromochloropropane (DBCP) and TCP from potable well water. Initial concentrations of EDB at 90 parts-per-trillion (ppt), DBCP at 75 ppt, and TCP at 0.25 to 2.5 parts-per-billion (ppb) were reduced to below their accepted detection limits by both processes. The design parameters, carbon use rate and transfer zone height were determined for the adsorption process. Activated carbon adsorption was recommended over either desorption method considered as the treatment method to implement at each site. The recommendation was based, to a large extent, on relative performance and treatment costs. With current analytical methods, it was not possible to even qualitatively detect the presence of contaminants in effluent samples from the activated carbon pilot plant. Waters sampled during the pilot tests with either the packed tower or the cooling tower always showed a contaminant residual. It was concluded that, with costs at least comparable, if not less than the alternatives, the superior performance of activated carbon warrants its selection as the technology to use. (See also W88-05809) (Lantz-PTT)
W88-05823

PILOT SCALE INVESTIGATION OF ALTERNATIVE DRINKING WATER TREATMENT PROCESSES AT EDMONTON, ALBERTA,
Alberta Univ., Edmonton. Dept. of Civil Engi-

neering.
P. M. Huck, D. Kellendonk, S. A. Daignault, W. B. Anderson, and D. K. Noot.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 241-261, 4 fig, 6 tab, 30 ref.

Descriptors: *Pilot plants, *Drinking water, *Water treatment, *Edmonton, *Disinfection, Alberta, Chlorination, Chlorine, Chloramine, Ozone, Chlorine dioxide, Activated carbon, Adsorption, Toxicity, Chemical analysis, Comparison studies, Gas chromatography.

The initial results of a pilot scale study undertaken to examine the effects of the disinfectants chlorine, chloramines, chlorine dioxide and ozone on drinking water quality are described. A pilot plant constructed of organically inert materials treated North Saskatchewan River water at Edmonton, Alberta. Four parallel process trains were provided, one for each disinfectant. Each train also included granular activated carbon (GAC). Water samples obtained after the various treatment steps were concentrated on XAD-2 resin. Comparison and evaluation of the disinfectants was achieved through gas chromatography/mass spectrometry (GC/MS) analysis in parallel with mutagenicity screening using the Ames Salmonella assay. The results reported here are for the first few months of the study, involving winter operation. Except on one occasion, the water was non-mutagenic prior to oxidant addition. Mutagenic activity was generally present following chlorine addition but was always eliminated by S9 rat liver fraction. No mutagenic response was observed in the chlorine dioxide stream, and the ozone stream was not yet operational at the time of writing. To-date, mutagenicity has been completely removed by GAC. A large number of organic compounds capable of adsorbing on XAD-2 resin were present in the water prior to oxidant addition. Gas chromatograms of XAD-2 eluates showed little change in the organic matrix following chloramination. Chlorine dioxide and chlorine addition produced changes in the gas chromatograms, and some compounds present only in the chlorine stream were tentatively identified. Samples obtained following granular activated carbon adsorption showed almost a complete absence of gas chromatographic compounds. (See also W88-05809) (Lantz-PTT)
W88-05824

**ORGANIC CONTAMINANT CONTROL: PILOT SCALE STUDIES AT JEFFERSON PARISH, LOUISIANA,**
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
B. W. Lykins, W. Koffskey, and R. G. Miller.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 263-282, 6 fig, 8 tab, 18 ref. Contract No. CS806925.

Descriptors: *Organic compounds, *Water quality control, *Pilot plants, *Water treatment, *Louisiana, *Disinfection, Chlorine, Monochloramine, Chlorine dioxide, Ozone, Chlorination, Ozonation, Organic carbon, Toxicity, Drinking water, Bioassay.

Disinfection of drinking water in the United States is accomplished by four major disinfectants: chlorine, monochloramine, chlorine dioxide, and ozone. These four disinfectants were applied to four parallel streams in a pilot plant located at Jefferson Parish, Louisiana. Several organics, including surrogates such as total organic carbon and total organic halide, were evaluated to investigate the effects of disinfection and treatment by sand filtration and granular activated carbon (GAC) adsorption. Also, five toxicological tests were conducted to determine the general toxicity and the mutagenic/carcinogenic potential of disinfection and/or GAC adsorption. Results of the study showed that ozonation produced less organics in most but not all cases. The short term animal toxicological studies revealed difficulties in analyzing actual drinking waters for detectable toxic effects. (See also W88-05809) (Author's abstract)
W88-05825

**DESIGN OF PILOT PROGRAM FOR ORGANICS REMOVAL AT NIAGARA FALLS,**
MacLaren Plansearch, Inc., Toronto (Ontario).
J. N. Hilton, R. F. Machacek, M. C. Kavanaugh, and K. J. Roberts.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 283-297, 4 fig, 2 tab, 9 ref.

Descriptors: *Pilot plants, *Niagara Falls, *Organic compounds, *Water treatment, *Ontario, Drinking water, Activated carbon, Niagara River, Model studies, Organic carbon, Canada, Process control, Monitoring.

As public concern for the quality of drinking water in Ontario continues to grow, considerable research has been undertaken to re-examine conventional treatment methodologies as well as alternate processes for the removal of trace levels of organic chemicals, including adsorption by granular activated carbon (GAC). This project has been undertaken to determine the following: the effectiveness of optimized conventional drinking water treatment for the removal of trace organic contaminants; the effectiveness of activated carbon adsorption removals of trace organic contaminants when used in the add-on contactor mode; and, process operational parameters for the optimized operation of full scale water treatment plants and GAC adsorbers used in the add-on mode for organics removal. Jar testing and pilot plant operations were conducted on site at the Niagara Falls Water Treatment Plant, using the Niagara River as the raw water source. Work performed to date on the selection of target monitoring compounds, the development of analytical protocols, the proposed experimental plant (including jar testing, conventional treatment, GAC treatment), the design of the pilot plant, and the analysis of data, are summarized. The model developed can be used to estimate the breakthrough of dissolved organic carbon (DOC) and synthetic organic compounds (SOCs) at their ambient concentrations in order to set regeneration criteria. The ambient concentration depends on the effectiveness of the upstream processes. Therefore, the organic loading on the carbon columns have varying ratios of DOC to SOCs. The associated operating costs could then be calculated, assuming this were the primary function of GAC contactors. If the primary function of GAC contactors were instead to provide a barrier against temporary high concentrations of SOCs, the model could be used to help evaluate operating criteria. (See also W88-05809) (Lantz-PTT)
W88-05826

**EVALUATION OF ORGANIC REMOVAL OPTIONS AT NEWPORT NEWS, VIRGINIA,**
CH2M/Hill, Denver, CO.
C. Hamann, R. C. Hoehn, E. R. Hoffmann, and E. G. Snyder.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 299-315, 10 fig, 3 tab, 5 ref.

Descriptors: *Organic compounds, *Newport News, *Virginia, *Performance evaluation, *Water treatment, *Water quality control, Flocculation, Filtration, Organic carbon, Activated carbon, Trihalomethane, Sludge, Ozone, Chlorine.

The City of New port news is conducting an intensive pilot plant program at the Harwood's Mill Water Treatment Plant to evaluate the dissolved organic removal capabilities of several innovative water treatment processes. The pilot studies were conducted with a unique floc-blanket clarifier (Infilco Degremont, Inc.'s Superpulsator) and the optimum of four filter media designs evaluated in preliminary pilot studies, a mixed media filter. The Superpulsator was capable of consistently producing clarified water turbidity of $< 1$ NTU at upflow rates as high 6.7 l/sq m/sec (4.0 gpm/sq ft). Total organic carbon (TOC removal across the Superpulsator and mixed media filter averaged about 44%. When powdered activated carbon (PAC) was added to the Superpulsator, the PAC was effectively entrained in the sludge blanket and did not appear to break through the clarifier or filter. Reductions of TOC and 7-day trihalomethane formation potential (THMFP) in the Superpulsator with PAC addition were not decreased by prechlorination. PAC in the sludge blanket appeared to reduce the instantaneous trihalomethane concentrations markedly. Preoxidation with ozone or chlorine dioxide without the presence of PAC in the Superpulsator appeared to have no effect on reductions of TOC or THMFP within the clarifier. (See also W88-05809) (Author's abstract)
W88-05827

**EFFECT OF TREATMENT ON ASSIMILABLE ORGANIC CARBON IN DRINKING WATER,**
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
D. Van der Kooij.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 317-328, 8 fig, 3 tab, 22 ref.

Descriptors: *Organic carbon, *Assimilative capacity, *Drinking water, *Water treatment, Bacteria, Biological studies, Filtration, Ozonation, Activated carbon, Chlorination, Organic compounds, Biological treatment.

A low concentration of easily assimilable organic carbon (AOC) is important for preventing bacterial regrowth in distribution systems. Biological processes in open storage reservoirs and during underground passage (including dune filtration and riverbank filtration) as well as filters with microbiological activity have a central function in water treatment in The Netherlands. Underground passage results in AOC values below 10 micrograms of acetate-C equivalents/L. Ozonation increases the AOC concentration by the production of carboxylic acids. AOC reductions by rapid sand filtration, GAC filtration and slow sand filtration increase with increasing influent AOC concentrations. Chlorination may slightly increase the AOC concentration. Next to the classical chemical and microbiological water quality parameters and the newly developed techniques for measuring individual organic contaminants, groups of organic compounds and mutagenicity, the AOC determination may be used to define design and operation of water treatment systems. (See also W88-05809) (Author's abstract)
W88-05828

**OPERATIONAL CRITERIA FOR PILOT PLANT STUDIES ON THE CONTROL OF ORGANIC CONTAMINANTS,**
Calgary Univ. (Alberta). Dept. of Chemical and Petroleum Engineering.
G. A. Irvine, A. Badakhshan, E. E. Hargesheimer, and C. M. Lewis.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 329-346, 10 fig, 2 tab, 32 ref.

Descriptors: *Organic compounds, *Pilot plants, *Water treatment, *Water quality management, Ozonation, Ozone, Flow rate, Monitoring, Turbidity, Water quality control, Temperature, Bacteria, Flocculation, Hydrogen ion concentration, Coliforms, Drinking water, Process control.

A pilot plant (PP) study into the effects of ozone treatment on the formation of trihalomethanes (THMs) in Calgary's drinking water as carried out. The PP was designed as a scaled-down version of the Glenmore Water Treatment Plant (GWTP) using the principles of similitude. The operational program developed to monitor this study assured that the results obtained in the PP were comparable to those from GWTP. The operational criteria

were simple and easy to follow. These criteria consisted in maintaining the water flow rates through the PP units proportional to the corresponding ones at GWTP, so as to provide similar residence times, and ensuring that raw and produced water qualities were similar to the corresponding ones at GWTP. The monitoring also determined that the treatment conditions within the PP were similar to what they would probably be at GWTP if ozone treatment were used there instead of prechlorination. PP raw water turbidity, temperature and bacterial populations were similar to the corresponding ones in GWTP raw water throughout the duration of the study. The use of suspended solids for the construction of the PP units did not result in total iron concentrations in PP water that could have significantly enhanced the removal of turbidity. The greater ratio of surface area to volume in the PP of flocculation cells and settling unit, compared to GWTP's, did not result in increased bacterial populations after those units that could have significantly changed the composition of the PP water with respect to organic compounds. Water produced at the PP met the requirements for drinking water in Canada with regard to temperature, turbidity, pH, nitrate concentration and heterotrophic and total coliform bacterial populations. This study has therefore demonstrated the effectiveness of ozone treatment at GWTP for the purpose of reducing total THM concentrations in Calgary's drinking water distribution system. (See also W88-05809) (Lantz-PTT)
W88-05829

**TREATMENT OF A MYCOTOXIN-CONTAMINATED FRESHWATER,**
Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
D. J. L. Forgie, and E. Davis.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 347-360, 1 fig, 5 tab, 10 ref.

Descriptors: *Mycotoxins, *Water treatment, *Biological studies, *Drinking water, Filtration, Fungi, Toxicity, Bioassay, Coagulation, Disinfection, Adsorption, Activated carbon.

Mycotoxins, such as the trichlorothecenes group, occur widely in nature as the result of the growth of certain species of fungi, e.g. Fusarium. The severe effects of these mycotoxins when mycotoxin-contaminated grains (e.g. corn and wheat) have been ingested by humans and/or animals are well documented. Since there is the possibility that surface drinking water supplies may become mycotoxin-contaminated, it was deemed necessary to investigate appropriate water treatment measures that would prevent public problems. The objective of this study was to determine which water treatment methods would be successful for the removal of mycotoxins from freshwaters. The test procedure was based on a 50 mg/L stock solution of T-2 mycotoxin in distilled water which was then subjected to various water treatment techniques. Samples of the product waters were analyzed qualitatively and quantitatively using both liquid and gas chromatographic techniques. In addition, animal testing was employed to evaluate the potential acute and chronic biological effects of the product waters. The results indicated that conventional water treatment techniques, i.e. coagulation, filtration and disinfection, have little or no effect in removing the particular mycotoxin which was tested. The most effective water treatment methods tested were adsorption on a synthetic resin, activated carbon adsorption, distillation, lime 'stabilization'. Subjecting the T-2 mycotoxin contaminated water to high pressure reverse osmosis treatment produced a treated water which yielded good results on TLC spot tests, G-C analysis and mice-force feeding tests, but poor results on the animal skin bioassay. The exact reasons for this apparent anomaly are, as yet, unknown. All other treatment methods including investigated conventional surface water treatment procedures, either did not produce acceptable product waters or were deemed to be unacceptable for practical implementation reasons. (See also W88-05809) (Lantz-PTT)
W88-05830

**SELF-HELP HANDBOOK,**
J. W. Schautz.
The Rensselaerville Inst., (1984). 199 p.

Descriptors: *Handbooks, *Management planning, *New York, *Water treatment, *Wastewater treatment, *Costs, *Public participation, Economic aspects, Water supply, Water resources development.

The primary purpose of this handbook for local government officials in New York State is to familiarize elected officials, community leaders, treatment system operators and concerned citizens with self-help concepts and strategies designed to reduce construction and reconstruction costs of water and wastewater projects to affordable levels. While the handbook specifically addresses water and wastewater system problems and cost-effective strategies for their resolution, the concepts and techniques offered can also be applied to other community projects. The State of New York's new Self-Help Support System also includes case studies, technical assistance (including some engineering, planning and legal advice) plus help with implementation provided by the Departments of State, Environmental Conservation and Health. From the state as well as the local perspective, the point of self-help is not only to bring about compliance with health and safety standards but to save money as well. If it is assumed that some 4,000 rural water and wastewater systems in New York need substantial maintenance or capital improvement and that, very conservatively, an average of $30,000 can be saved using some self-help strategies on those improvements, the total savings across the state is $120 million. While each community can be expected to be motivated to save $30,000, it is also safe to assume that the state government can be motivated to save $120 million. To encourage community consideration of self-help projects, this manual is designed to be a desk-top reference with the Table of Contents serving as an informal checklist of considerations and tasks. Part I discusses a variety of self-help strategies and examples, grouped into three major categories: Making All Possible Use of Local Resources, Getting the Most from the Outside World, and Essential Actions Before Construction, many items of which should be underway simultaneously. Part II is a briefer look at the context of the system, discussing the needs in rural New York as well as the do-it-yourself implications of the self-help system. (Lantz-PTT)
W88-05843

**EXTENSION OF WATER QUALITY DATA BASES IN PLANNING FOR WATER TREATMENT,**
California Univ., Davis.
For primary bibliographic entry see Field 7B.
W88-05874

**MODELLING OF BACTERIAL POPULATIONS AND WATER QUALITY MONITORING IN DISTRIBUTION SYSTEMS,**
Centre des Sciences de l'Environment, Metz (France).
For primary bibliographic entry see Field 5A.
W88-05876

## 5G. Water Quality Control

**QUALITY REQUIREMENTS FOR IRRIGATION WITH SEWAGE WATER,**
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 3C.
W88-05139

**HYPOLIMNETIC WITHDRAWAL AS LAKE RESTORATION TECHNIQUE,**
York Univ., Downsview (Ontario). Dept. of Biology.
G. K. Nurnberg.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 1006-1017, October 1987. 4 fig, 5 tab, 20 ref.

Descriptors: *Hypolimnetic withdrawal, *Phosphorus, *Lake restoration, *Limnology, *Lake withdrawal, Anoxia, Hypolimnion, Epilimmion, Lakes, Thermal Stratification.

Hypolimnetic withdrawal is a lake restoration technique based on the damming of surface outflow and the discharge of hypolimnetic water. In 17 lakes, hypolimnetic withdrawal has been used for 1-10 yrs. In general, anoxia and total phosphorus (TP) concentrations of epi- and hypolimnetic water decreased after the commencement of withdrawal. The decrease of epilimnetic TP concentration correlates to TP export via hypolimnetic withdrawal and becomes stronger with years of operation. While it is advisable to maximize TP export to improve lake conditions, two constraints have to be observed: (1) the lake level should remain constant; and (2) the thermostructure must not be disturbed. Maximum TP export can be obtained by positioning the withdrawal pipe deep in the hypolimnion and operating the system when hypolimnetic TP concentrations are high. Under these circumstances treatment of the withdrawn water might become necessary to avoid fertilization of downstream waters. (Author's abstract)
W88-05162

**CHANCE CONSTRAINED MODEL FOR RIVER WATER QUALITY MANAGEMENT,**
Asian Inst. of Tech., Bangkok (Thailand). Div. of Industrial Engineering and Management.
O. Fujiwara, S. K. Gnanendran, and S. Ohgaki.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 1018-1031, October 1987. 4 fig, 1 tab, 25 ref.

Descriptors: *Water quality management, *Model studies, *River basins, *Wastewater treatment, Design standards, Rainfall, Rivers, Basins, Water quality, Storm runoff, Tributaries.

A chance constrained model is proposed, in which the main stream, tributaries, and storm water are considered as random variables to determine the most economical level of wastewater treatment at each discharge city or industry along a river basin. The model considered the risk of violation of the stream-water quality explicitly and therefore, provides a more rational approach than the traditional design value or safety factor approach, e.g., the lowest 7-day moving average of daily flow rate over a 10-yr period. The model is shown to be equivalent to a linearly constrained program, thus enabling the application of simple solution techniques. (Author's abstract)
W88-05163

**WATER SUPPLY SYSTEMS IN BLUE NILE HEALTH PROJECT,**
Blue Nile Health Project, Wad Medani (Sudan).
For primary bibliographic entry see Field 5F.
W88-05177

**HYDRODYNAMIC DESIGN OF A METALIMNETIC LAKE AERATOR,**
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
H. G. Stefan, M. D. Bender, J. Shapiro, and D. I. Wright.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1249-1264, December 1987. 14 fig, 3 tab, 14 ref.

Descriptors: *Hydrodynamic design, *Lake aerators, *Lake restoration, *Limnology, *Water quality, *Lake management, Metalimnion, Aeration, Lakes, Field tests, Design standards.

Improvement of water quality in the metalimnetic layer of a stratified lake has been proposed as a lake management technique. Hydrodynamic design and operation requirements of a metalimnetic lake aerator are presented. Laboratory and field data illustrate the hydrodynamic feasibility of water

quality manipulation in the intermediate depth strata of a stratified lake. The design of a metalimnetic aerator requires analysis of various internal and external flow aspects, including (1) the metalimnetic dissolved oxygen depletion rate; (2) the required air supply rate; (3) the required piping and compressor capacity; (4) dimensions of aerators ports; and required ad desing water flow rate. Determination of these parameters is described for the case of Ryan Lake, Minnesota, a 7.3 ha lake of 11 m maximum depth. Lake experiments verified the hydrodynamic correctness of the design. However, the oxygen demand target for the metalimnion was not met. Laboratory and field experimentation showed that water can be manipulated in a lake metalimnion without destroying whole lake temperature stratification. (Alexander-PTT)
W88-05179

**RISK MODEL FOR STORM SEWERS WITH SUBMERGED OUTLETS,**
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W88-05187

**ANEROBIC BACTERIA THAT DECHLORINATE PERCHLOROETHENE,**
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
B. Z. Fathepure, J. P. Nengu, and S. A. Boyd.
Applied and Environmental Microbiology AEMIDF, Vol. 53, No. 11, p 2671-2674, November 1987. 2 fig, 2 tab, 20 ref.

Descriptors: *Water treatment, *Wastewater treatment, *Fate of pollutants, *Perchloroethene, *Chlorinated hydrocarbons, *Anaerobic bacteria, Bacteria, Methane bacteria, Biodegradation, Degradation, Oxidation, Biological treatment.

Methanosarcina sp., M. mazei, and strain DCB-1, an obligate anaerobe which dechlorinates chlorobenzoate, were shown to dechlorinate perchlorethene (PCE), a common groundwater contaminant. Bacteria which did not significantly dechlorinate PCE were M. acetivorans, Methanothrix sp., Desulfovibrio desulfuricans, Clostridium pasteurianum, and C. butyricum. In pure culture DCB-1 degraded about 180 nmol of PCE per 50 ml in 6 weeks. In a culture of DCB-1 and a methanogenic consortium, PCE was degraded more rapidly; 220 nmol of PCE per 50 ml was completely degraded within 1 week. (Cassar-PTT)
W88-05195

**FARM AND WATERSHED ECONOMIC IMPACTS OF AGRICULTURAL POLICY. APPROACHES TO REDUCE SOIL EROSION AND SEDIMENTATION,**
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6C.
W88-05199

**INTEGRATING DEMAND MANAGEMENT OF URBAN REGIONAL WATER SYSTEMS: A CANADIAN CASE STUDY AND IMPLICATIONS,**
Michigan Univ., Ann Arbor.
For primary bibliographic entry see Field 6D.
W88-05206

**ENVIRONMENTAL MANAGEMENT OPTIONS IN THE CONTROL OF WATER RELATED DISEASES IN THE LAGOS METROPOLITAN AREA OF NIGERIA,**
Oklahoma State Univ., Stillwater. Graduate Coll.
I. M. Akinmoladun.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8610332. Ph.D Dissertation, 1986. 150 p, 13 fig, 22 tab, 61 ref, 8 append.

Descriptors: *Model studies, *Nigeria, *Environmental sanitation, *Environmental policy, *Wastewater management, *Water quality management, *Management planning, Cost-benefit analysis, Developing countries, Sanitary engineering, Epidemiology, Public health.

An environmental management model was developed for controlling water-related diseases in Lagos, Nigeria. The model stipulates that continuous education of the government and the public must be maintained. The Federal Government should appropriate more funds to assist in carrying out water and wastewater projects. All programs associated with water-related disease control should be evaluated annually to determine their adequacy, effectiveness, and efficiency. A follow-up study should be done after the plan for water-related disease control is implemented to evaluate the impact of water and wastewater projects on the health, quality of life, the growth pattern of the Lagos' population, and the economy. (Cremmins-AEPCO)
W88-05209

**FIELD AND BASIN SCALE WATER QUALITY MODELS FOR EVALUATING AGRICULTURAL NONPOINT POLLUTION ABATEMENT PROGRAMS IN A SOUTH FLORIDA FLATWOODS,**
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
C. D. Heatwole.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8704170. Ph.D Dissertation, 1986. 184 p, 14 fig, 36 tab, 153 ref, 4 append.

Descriptors: *Path of pollutants, *Model studies, *Hydrologic models, *Water pollution control, *Nonpoint pollution sources, *Agricultural runoff, *Agricultural watersheds, Chemical reactions, Nutrients, Mathematical models.

A water quality model was developed to evaluate the effectiveness of best management practices (BMP) for evaluating agricultural nonpoint pollution abatement in South Florida flatwood watersheds. The model encompasses field and basin scale simulation and addresses storage-based hydrology, low chemical reactivity with sand soils, nutrient uptake in wetlands, and management practices for pasture and dairy land. Model findings indicate that flatwoods watersheds are storage-based hydrologic systems; therefore, the SCS runoff equation, which is a storage-based model, is suitable for predicting runoff from these watersheds, although an appropriate estimate of the storage parameter, S, must be determined. The SCS runoff equation as modified for the CREAMS-WT model is particularly appropriate for flatwoods watersheds, enabling realistic physical determination of the storage parameter and incorporating in simple form the variable source area concept. The CREAMS-WT hydrology model conceptually represents the major components of the hydrologic system of flatwoods watersheds and can give reasonable predictions of annual water balance components without calibration. The CREAM-WT nutrient model can give reasonable predictions of annual nitrogen and phosphorus loads from flatwoods watersheds without calibration. The BASIN model gives reasonable estimates of average annual loads from the Taylor Creek-Nubbin Slough basin and sub-watersheds, and should be applicable to other similar flatwoods watersheds. The CREAMS-WT and BASIN models can be used to evaluate the relative effectiveness of alternative management practices at the field level and at the watershed/basin outlet. (Cremmins-AEPCO)
W88-05211

**LINEAR PROGRAMMING APPROACH FOR MANAGING GROUNDWATER POLLUTION FROM PESTICIDES: A COMPARATIVE ANALYSIS OF ECONOMIC AND ENVIRONMENTAL RISK,**
Cornell Univ., Ithaca, NY. Graduate School.
F. S. Bretas.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8623178. Ph.D Dissertation, 1986. 299 p, 22 fig, 72 tab, 123 ref, 2 append.

Descriptors: *Model studies, *Water pollution control, *Linear programming, *Groundwater pollution, *Farm management, Pesticides, Economic aspects, Farming, Economic efficiency, Model studies, Profit, Leaching, Farms.

A linear programming methodology was developed for the analysis of the trade-off's between farmer net income gains or losses and the permissible levels of pesticides in groundwater under environmental and economic (weather and crop price) uncertainty. Conflicting objectives in the study are profit maximization and the protection of groundwater from pesticide pollution. Yearly amounts of pesticides leached to the groundwater from a particular soil, crop, and management combination, in excess of water quality standards, were used as coefficients of the linear programming model. Pesticide leaching coefficients were obtained using a BASIC version of the Pesticide Root Zone Model (PRZM). Sensitivity analysis was used to analyze trade-offs between farm income and groundwater quality; and the linear programming MOTAD (Minimization of Total Absolute Deviations) was used to describe price variability. The methodology was tested using data from a typical Long Island potato farm. The methodology may be applied whenever there is a conflict between pesticide use for agricultural production and groundwater quality. Three levels of analysis are possible: deterministic, probabilistic, and economic risk. The methodology may be easily modified to be applied to the selection of sites for land disposal of organic wastes. Limitations of the model include: the PRZM model has limited validation, the estimation of the pesticide decay rates has a considerable degree of uncertainty, and the use of the variance as a measure of economic risk may be inappropriate under certain circumstances. (Cremmins-AEPCO)
W88-05212

**PREDICTION OF NUISANCE BLUE-GREEN ALGAL GROWTH IN NORTH CAROLINA WATERS,**
North Carolina Univ. at Chapel Hill. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W88-05227

**USE OF WATER QUALITY MODELS IN BELGIUM,**
Brussels Univ. (Belgium). Lab. of Hydrology.
A. Van Der Beken.
Water Science and Technology WSTED4, Vol. 19, No. 7, p 1197-1202, 1987. 4 fig, 2 tab, 2 ref.

Descriptors: *Water quality, *Model studies, *Data interpretation, *Wastewater treatment, *Alternative planning, *Water quality management, Computers, Canals, Belgium, Velpe River, Albert canal, Campine canal, Evaluation.

The surface water quality model QUAL-II from the USEPA and a series of models for the Albert canal and Campine canal system are described. The QUAL-II model was applied as a planning model for evaluating the effects of alternative wastewater treatment schemes along the Velpe River and its tributaries in Belgium. The steady state model simulated the dispersion and advection of conservative and reacting constituents by numerical integration of the one-dimensional form of the equations. Specific problems in smaller basins required modification of the computer program. The water quality in the river expected as a result of regional large-scale wastewater treatment plants was compared to the quality expected from small-scale autonomous plants. The current situation was simulated along with various scenarios of small scale techniques. The model proved to be applicable as a planning model and was operational for a mainframe computer as well as a micro computer. The second series of models was based on the one-dimensional advection-dispersion equation with source or sink terms for non-conservative constituents. The series was developed to obtain: (1) a better knowledge of the temporal and spatial variation of the raw water quality in the canal system, (2) an operational calculation technique to forecast the raw water quality at the intake points, (3) a forecast of the temporal and spatial evolution of an accidental pollutant spill in the canal system, and (4) a rationalization of the monitoring measurement network. Raw water quality forecasting, given the daily average concentrations at the beginning of

the canal system, is possible for conservative constituents on a mainframe computer; extensive calibration is still required for non-conservative constituents. With a micro computer with a graphics program, the simulation of accidental waste discharge at any point in the canal system is possible. (Wood-PTT)
W88-05252

**EUTROPHICATION OF LAKE SAVA,**
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
For primary bibliographic entry see Field 5C.
W88-05269

**BIG CHANGES AHEAD FOR DRINKING WATER INDUSTRY,**
CWC-HDR, Inc., Edmonds, WA.
For primary bibliographic entry see Field 5F.
W88-05275

**PURITY CRUSADE TAKES ON THE DRINKING WATER INDUSTRY,**
For primary bibliographic entry see Field 5F.
W88-05276

**SECOND REPORT ON THE WATER SUPPLY OF THE PEOPLE'S REPUBLIC OF CHINA,**
Zurich Water Supply (Switzerland).
For primary bibliographic entry see Field 5B.
W88-05279

**FORMULATION OF MODELS AND OPTIMIZATION OF UNTREATED WATER STORAGE OPERATIONS AT THE MERY-SUR-OISE PLANT FOR THE PRODUCTION OF DRINKING WATER,**
Compagnie Generale des Eaux, Paris (France).
For primary bibliographic entry see Field 5F.
W88-05282

**WATER SUPPLY: POSSIBLE CONSTRAINTS ON SOCIO-ECONOMIC DEVELOPMENT IN OYO STATE OF NIGERIA,**
Nigerian Inst. of Social and Economic Research, Ibadan.
For primary bibliographic entry see Field 4C.
W88-05284

**RESERVOIR MANAGEMENT,**
Waco City Environmental Quality and Water Purification Dept. (Texas).
M. D. Meadows.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 8, p 26-31, August 1987.4 fig, 3 tab, 5 ref.

Descriptors: *Water quality control, *Lakes, *Water storage, *Reservoir operation, *Algal control, *Destratification, Waco, Texas, Aeration, Oxygenation, Watershed management, Algal blooms, Algicides, Copper sulfate, Monitoring, Taste control, Odor control, Cyanophyta, Dissolved oxygen.

Destratification with compressed air successfully control taste- and odor-causing blue-green algae in Lake Waco Reservoir, the raw water storage for the City of Waco, Texas. The reservoir, fed by three major tributaries, began impoundment in February 1965, engulfing an old reservoir and dam site. Maximum depth is 85 ft; average depth, 35 ft. A routine sampling program includes sampling at five representative stations. The destratification of the reservoir is accomplished by adding compressed air in the low, oxygen-deficient portions of the lake and its tributaries. Although it was expected that nutrients brought from the bottom would contribute to algal blooms, this was not a significant problem. Additional taste and odor control is accomplished by spraying or broadcasting copper sulfate at the rate of 0.25-0.5 mg/liter. Watershed monitoring activities include visual observations from air and land and contingency plans in case of accidental spill of toxic pollutants into the watershed. Illegal discharges, such as brine from drilling operations, are actively prevented through regulatory agencies. (Cassar-PTT)
W88-05334

**LAKE SEDIMENTATION REDUCTION TECHNIQUES,**
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 4D.
W88-05353

**SUSPENDED SEDIMENT AND METALS REMOVAL FROM URBAN RUNOFF BY A SMALL LAKE,**
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 5D.
W88-05400

**INSTITUTIONAL AND HUMAN RESOURCE DEVELOPMENT FOR WATER QUALITY-CONTROL PROGRAMS IN DEVELOPING COUNTRIES,**
Agency for International Development, Washington, DC. Office of Health.
J. H. Austin, K. J. Austin, and H. Otterstetter.
CRC Critical Reviews in Environmental Control CCECAU, Vol. 17, No. 4, p 253-272, 1988. 2 fig, 4 tab, 95 ref.

Descriptors: *Reviews, *Developing countries, *Water quality control, *Human resources, Economic aspects, Political aspects, Water quality standards, Institutions, Training.

For effective water quality control to take place and be maintained under a particular set of political, economical, social, and technological conditions, institutions must set realistic standards of performance for themselves and establish the circumstances under which they can meet these standards. The various areas which must be considered are organizational, technical, technological, and human resources. The problems faced by the practitioners in water quality control in the developing world are reviewed and relevant literature related to the four areas discussed. Practical approaches are briefly stated to assist persons working in the water quality control field in developing countries to select procedures for their particular problems. Special emphasis is directed at the institutions responsible for water quality control and the human resource needs required for an effective organization. Development of human resources is often a major shortcoming in the developing world, and thus a section on procedures for preparing adequate human resources is included. (Alexander-PTT)
W88-05426

**APPROACHING POLLUTION CONTROL VIA THE WALLET,**
C. B. MacKerron.
Chemical Week CHWKA9, Vol. 141, No. 18, p 41-42, October 28, 1987.

Descriptors: *Reviews, *Water pollution control, *Economic aspects, *Permits, *Regulations, Financial incentives, Air pollution control.

A program is described that is based on marketable permits to pollute air and water that would be auctioned off periodically by the government. A system based more on economic incentives could result in cheaper, more efficient environmental regulation than the current system. By charging high fees for permits to pollute, the law school professors say, a powerful financial incentive would be created 'for those who can clean up most cheaply to sell their permits to those whose treatment costs are highest,' resulting in a least-cost allocation of control burdens. (Alexander-PTT)
W88-05428

**IMPROVEMENTS IN WATERSHED MANAGEMENT ENHANCE CASH FLOW,**
Washington Suburban Sanitary Commission, Brookeville, MD.
For primary bibliographic entry see Field 4D.
W88-05431

**GROUNDWATER CONTAMINATION BY TEMIK ALDICARB PESTICIDE: THE FIRST 8 MONTHS,**
Harvard School of Public Health, Boston, MA. Interdisciplinary Programs in Health.
D. Wartenberg.
Water Resources Research WRERAO, Vol. 24, No. 2, p 185-194, February 1988. 1 tab, 54 ref. EPA Grant CR-807809-01.

Descriptors: *Legal aspects, *Pollution control, *Drinking water, *Regulations, *Path of pollutants, *Water pollution sources, *Pesticides, *Groundwater pollution, Public health, Institutional constraints, New York.

In 1979, Temik aldicarb pesticide was detected in the groundwater of Suffolk County, New York. Concentrations detected in drinking water supplies exceeded health guidelines, causing concern among thousands of residents. In spite of suggestive evidence prior to detection and inquiries from local investigators, EPA did not consider contamination a likely event. Upon detection of the contamination, EPA officials instituted an emergency response. Then, when they were sure there was no acute hazard, they left the situation in the hands of local health authorities, who struggled without adequate resources or sufficient in-house expertise. The local officials' failure to acknowledge these limitations led to public mistrust and discontent. From this case study one sees the consequences of limited implementation of the federal pesticide regulatory system. More stringent requirements would have likely prevented the contamination. In addition, an integrated response from agencies at many levels of government would have helped prevent similar contamination elsewhere and provided more comprehensive management of this episode on Long Island. Openness by government officials on the limitations of the health data would have helped defuse public animosity and encouraged a more satisfactory resolution of the contamination. (Author's abstract)
W88-05432

**CLEANUP ON A LARGE SCALE,**
CH2M Hill, Newport Beach, CA. Southern California Regional Office.
T. L. Foreman, and N. L. Ziemba.
Civil Engineering CEWRA9, Vol. 57, No. 8, p 46-48, August 1987. 1 fig.

Descriptors: *Path of pollutants, *Water pollution sources, *Water quality control, *Chlorinated hydrocarbons, *Groundwater pollution, San Gabriel Valley, California, Trichloroethylene, Landfills, Water treatment, Water supply, Water rights, Wells, Pumping, Institutional constraints, Political constraints.

The lack of physical barriers has allowed groundwater contamination to spread throughout the San Gabriel Basin. Already 30% of the present 87 water producers have been polluted with 18 toxic chemicals, some found as deep as 700 ft. Trichloroethylene, perchloroethylene and carbon tetrachloride have been identified in the highest concentrations. Studies show that contamination is likely to spread to as many as 20 more producers (90 wells) within 5-20 years. The lack of sufficient alternative water supplies makes water salvage the most logical solution. However, an easy and inexpensive remedy is not likely for several reasons. More than 50 entities own water rights in the basin. Pumping is not controlled or coordinated so that contamination spread is minimized. Alternate water sources must consider water rights. At least 24 municipalities, each with individual ordinances, must be considered. Interim methods for handling the contaminated supplies include abandoning some wells, blending water with clean water, boiling water, using bottled water for drinking, treating with activated carbon, drilling of deeper wells. Studies are underway to develop a long-term, coordinated plan for managing water quality in this basin. (Cassar-PTT)
W88-05476

**STOCHASTIC DISSOLVED OXYGEN MODEL,**
Gore and Storrie Ltd., Toronto (Ontario). Water Resources Div.
For primary bibliographic entry see Field 5B.
W88-05511

**WATER JET-INDUCED CIRCULATION IN CHANNEL: III. COMPARISON WITH AERATION,**
Shell Development Co., Houston, TX.
J. Wen, and R. S. Torrest.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 154-165, February 1988. 9 fig, 14 ref.

Descriptors: *Water pollution treatment, *Water circulation, *Channels, *Aeration, Lakes, Reservoirs, Channel flow, Water jets, Velocity distribution, Injection, Velocity, Surface velocity, Surface flow, Mathematical equations.

Circulation and mixing of lakes and reservoirs resulting from air plumes brings about a simultaneous buildup of dissolved oxygen. The same kind of circulation, but without direct oxygen addition, can be achieved with water jets which can, in addition, be set at any orientation. Measurements of the velocity profiles and circulation for water injection through a linear manifold in a channel are presented and compared with those for aeration-induced circulation. In particular, the velocity profiles above the manifold set at the channel bottom, lateral surface flow profiles, the extent of circulation, and the influence of manifold positions are described. The results are similar to those for aeration in most respects. For water-injection rates to 2.3 cu dm/m/sec (11 gpm/ft), the maximum lateral surface velocity was directly proportional to the rate and varied inversely with the square root of manifold depth. Surface current thickness increased linearly with lateral distance out to the end of the circulation cell at four times the depth. A simple equation is presented for the equivalence of flows induced by water jets and aeration. (Author's abstract)
W88-05516

**SEALING WELL CASING: AN IDEA WHOSE TIME HAS COME,**
D. E. Calhoun.
Water Well Journal WWJOA9, p 25-29, February 1988. 2 tab.

Descriptors: *Well casings, *Bentonite, *Grouting, Pumping, Slurries, Drilling, Groundwater pollution.

Many drilling contractors are re-evaluating the way they install and seal well casing largely because the public is becoming more aware of ground water pollution. Case studies illustrate the misuse and absence of grout: (1) where drill cuttings were used for grout, (2) where well casing was driven as drilling proceeded, and (3) where the seal was made of bentonite drilling mud and cuttings. Grouting techniques and a wide range of grouting materials now used in the water well industry are discussed. Recent research at the University of Wisconsin found three solutions to the problem of producing pumpable high solids grout slurries. Contractors should use good grouting material to seal the annulus of the well. A good grouting material is one that can be easily placed, develops strength quickly, creates a positive seal, will not break down and, above all, is impermeable. (Miller-PTT)
W88-05549

**DEFORESTATION OF LARGE RESERVOIR BASINS,**
Rua Baronesa de Pocone, Rio de Janeiro (Brazil).
For primary bibliographic entry see Field 4C.
W88-05553

**REMOVAL OF ORGANICS FROM LEACHATES BY ANAEROBIC FILTER,**
Toronto Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W88-05598

**IMPLEMENTING DUAL-PURPOSE STORMWATER DETENTION PROGRAMS,**
New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources.
For primary bibliographic entry see Field 4D.
W88-05614

**ELEMENTS OF A COMPREHENSIVE STORMWATER MANAGEMENT PROGRAM,**
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 4D.
W88-05615

**ORGANOCHLORINE RESIDUES IN NORTHEASTERN ALBERTA OTTERS,**
Alberta Environmental Centre, Vegreville.
For primary bibliographic entry see Field 5B.
W88-05617

**ZONING TO PROTECT GROUNDWATER QUALITY,**
Wisconsin Univ.-Madison. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6E.
W88-05664

**CHANGING AGRICULTURAL PROPERTY RIGHTS IN THE ENVIRONMENTAL ERA,**
Purdue Univ., Lafayette, IN. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6E.
W88-05670

**REGULATIONS FOR PROTECTING GROUNDWATER AGAINST AGRICULTURAL POLLUTANTS,**
Wisconsin Univ., Madison. Law School.
For primary bibliographic entry see Field 6E.
W88-05671

**LITTLE WATERS: THE RELATIONSHIP BETWEEN NON-POINT SOURCE WATER POLLUTION, SOIL EROSION AND AGRICULTURAL DRAINAGE,**
South Dakota Univ., Vermillion. School of Law.
For primary bibliographic entry see Field 6E.
W88-05672

**LEGAL, ECONOMIC AND POLITICAL CONSTRAINTS ON MANAGING AGRICULTURAL DRAINAGE WATER IN CALIFORNIA,**
Westlands Water District, Fresno, CA.
For primary bibliographic entry see Field 6E.
W88-05673

**BUILDING MARKETS FOR TRADABLE POLLUTION RIGHTS,**
Clemson Univ., SC. Dept. of Economics.
For primary bibliographic entry see Field 6E.
W88-05688

**NEW PERSPECTIVES ON POLLUTION CONTROL: CROSS-MEDIA PROBLEMS.**
Conservation Foundation, Washington, DC.
Proceedings of a Conference Held at Washington, DC., November 13, 1984. The Conservation Foundation, Washington, DC. 1985. 88 p.

Descriptors: *Water pollution control, *Water law, *Environmental policy, *Symposium, *Path of pollutants, Water management, Air pollution, Research priorities, Environmental protection, Waste management.

Although there is only one natural environment, many environmental institutions and policies attempt to control pollutants in air, water, and land separately, often by merely transferring the pollutants from one medium to another. Water pollutants may be volatilized into the air or collected and disposed of on land as sludge, thereby allowing the possibility for contamination of another medium. Present policies often fail to reduce levels of some pollutants in the overall environment. To examine this cross-media problem and what can be done about it, The Conservation Foundation sponsored a conference in November 1984 on the new dimensions of pollution problems. The papers presented at that conference, along with comments and additional discussion are compiled in this report. The perspectives included represent those of government officials, corporate executives, environmentalists, researchers, and others. The extent of the cross-media problem, priorities for future research, and the implications that cross-media problems have for environmental policy are considered. (Geiger-PTT)
W88-05691

**CONTROLLING CROSS-MEDIA POLLUTANTS.**
Conservation Foundation, Washington, DC.
The Conservation Foundation, Washington, DC. 1984. 54 p.

Descriptors: *Waste management, *Path of pollutants, *Water pollution sources, *Water pollution control, Water pollution prevention, Monitoring, Water law, Environmental policy, Air pollution, Environmental protection.

Pollutants may move from one medium to another, causing damage in each. U. S. envrionmental control laws and programs, however, seek to control pollutants as if they remain in the same medium. This narrow focus can undermine the effectiveness of the laws. The cross-media approach to pollution control has four dimensions paralleling the stages of pollution control: release from a source, waste management, cycling of pollutants in the environment, and exposure of people and the environment. A more integrated approach to environmental control could help deal with pollutants that move among media. Among the possible steps in such an approach are: concentrating research and monitoring on identifying how pollutants move, degrade, and accumulate; encouraging the recycling, treatment, or secure containment of wastes, rather than their disposal on land; improving coordination among environmental agencies; and consolidating environmental laws. (Geiger-PTT)
W88-05692

**LIMNOLOGICAL EFFECTS OF ARTIFICIAL AERATION AT LAKE CACHUMA, CALIFORNIA, 1980-1984,**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
J. J. Sartoris, and J. R. Boehmke.
Available from the National Technical Information Service, Springfield, VA. 22161. Bureau of Reclamation Report No. REC-ERC-87-10, March 1987. 56 p, 28 fig, 18 tab, 27 ref, 2 append. Bureau of Reclamation PRESS Project No. DR-409.

Descriptors: *Limnology, *Artificial aeration, *Lake Cachuma, *California, *Water quality, *Thermal stratification, *Lake restoration, *Destratification, Environmental effects, Stratification, Seasonal variation, Aeration, Nutrients, Chlorophyll, Plankton, Dissolved oxygen, Chemical analysis, Water temperature, Monitoring, Reservoirs.

Lake Cachuma, a Bureau of Reclamation water-supply reservoir in southern California, had routinely experienced severe hypolimnetic oxygen depletion during summer stratification. A diffused-air aeration system was installed near the dam outlet in May 1981, to alleviate the water quality problems arising from this anoxia. Surveys to monitor the limnological effects of aeration were begun in April 1980, and continued through September 1984. Results from four seasons of operation (1981-84) showed that aeration weakened, but did not completely destroy thermal stratification. Thus, the epilimnetic conditions of light penetration, nutrient and chlorophyll concentrations, and plankton populations were largely unaffected by aeration. In the hypolimnion, however, dissolved oxygen concentrations and temperature increased,

while manganese, sulfide, bicarbonate, ammonia, and orthophosphate phosphorus concentrations decreased. At the same time, iron, nitrite, and nitrate concentrations increased. In the benthos, chironomid populations increased significantly at all stations, while oligochaetes declined somewhat at the upreservoir stations. Before the aeration system was installed, water quality deteriorated to extremely poor levels by early August. However, water users in the lower Santa Ynez River Valley reported that aeration extended the period of acceptable water quality by about a month to a month and a half. (Author's abstract)
W88-05696

**GUIDELINES FOR PLANNING COMMUNITY PARTICIPATION ACTIVITIES IN WATER SUPPLY AND SANITATION PROJECTS,**
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 6B.
W88-05698

**DRINKING WATER MICROBIOLOGY.**
For primary bibliographic entry see Field 5F.
W88-05707

**PARADISE STEAM ELECTRIC PLANT, ASH-POND TOXICITY BIOMONITORING STUDY - OCTOBER 1986,**
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
J. Moses, and W. C. Barr.
Available from the National Technical Information Service, Springfield, VA 22161, as DE87-900619. Price codes: A02 in paper copy, A01 in microfiche. Tennessee Valley Report No. TVA/ONRED/WRF-87/6, January 1987. 17 p, 3 tab, 1 ref, 2 append.

Descriptors: *Bioindicators, *Settling basins, *Precipitator ash, *Neutralization, *Hydroelectric powerplants, *Water quality control, *Toxicity, *Monitoring, *Water pollution effects, *Green River, Kentucky, Wastewater pollution, Daphnia, Bioassays, Biological analysis, Toxins, Acidity, Hydrogen ion concentration.

The Tennessee Valley Authority (TVA) owns and operates Paradise Steam-Electric Plant (PAF) as an integral part of the agency's electric power network. Precipitator ash from this three unit, 2,558 MWe coal-fueled facility is sluiced to an 83 acre (33.5 ha) settling pond, with supernatant discharged at an average flow of about 53 cfs (1.51 cu m/mc) to Jacobs Creek (outfall 001), a small tributary of the Green River. In compliance with pH limitations of the National Pollutant Discharge Elimination System (NPDES) permit immediately proceeding the current Kentucky Pollutant Discharge Elimination System (KPDES) permit, neutralization of precipitator ashpond effluent was effected in 1979 and a biomonitoring program instituted. The current permit notes that the receiving stream, Jacobs Creek, is on occasion a zero flow stream and requires chronic toxicity testing of the effluent. These studies assess effects based on the general standard of 'no toxic materials in toxic amounts,' guided by procedures in the EPA Chronic Bioassay Manual. TVA's testing procedures included one daphnid (7-day Ceriodaphnia sp. lifecycle test) and one fish (7-day fathead minnow, Pimephales promelas, growth test) assay selected from the approved group of chronic toxicity tests assay. Presented here are the results from the first of four quarterly chronic toxicity bioassays, initiated on October 14, 1986. (Lantz-PTT)
W88-05710

**COMPUTERS IN THE WATER INDUSTRY: IMPACT ON THE REGULATORY PROCESS,**
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
For primary bibliographic entry see Field 5F.
W88-05711

**ECOLOGICAL RECOVERY AFTER RECLAMATION OF TOXIC SPOILS LEFT BY COAL SURFACE MINING. PHASE II: AN ASSESSMENT OF ENVIRONMENTAL CHANGES FOLLOWING INTENSIVE REMEDIAL TREATMENTS,**
Tennessee Valley Authority, Norris. Div. of Land and Economic Resources.
For primary bibliographic entry see Field 4C.
W88-05718

**PROCEEDINGS OF THE 1986 INTERNATIONAL SYMPOSIUM ON BIOFOULED AQUIFERS: PREVENTION AND RESTORATION.**
American Water Resources Association, Bethesda, MD.
For primary bibliographic entry see Field 5C.
W88-05724

**POLICIES RELATING TO GROUNDWATER AND BIOFOULING,**
Environmental Protection Agency, Atlanta, GA. Region IV.
For primary bibliographic entry see Field 6E.
W88-05725

**OCCURRENCE OF IRON BACTERIA IN WELLS IN RIO NEGRO (ARGENTINA),**
Departamento Technico Lab., Viedma (Argentina).
For primary bibliographic entry see Field 2F.
W88-05737

**RESOURCE ENHANCEMENT AT HAZARDOUS WASTE SITES,**
Woodward-Clyde Consultants, Walnut Creek, CA.
B. P. Popkin.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 137-142, 1 ref.

Descriptors: *Hazardous wastes, *Water pollution control, *Resources management, *Waste disposal, *Disposal sites, *Hazardous waste, Regulations, Costs, Economic aspects, Cleanup operations, Groundwater pollution, Waste treatment, Soil contamination.

Thousands of potentially responsible parties (PRPs) and regulatory agencies are conducting remedial investigations/feasibility studies (RI/FSs) at tens of thousands of hazardous waste sites in the United States. The PRPs and agencies expect to spend tens of millions of dollars at each site to restore them to background, regulatory-mandated, or lower receptor-risk conditions. Many sites are located on otherwise prime property with good access and at industrial parks with full utilities. Billions of cubic yards of soil will be excavated, and trillions of gallons of groundwater will be pumped; contaminated soil and water will be treated to remove or stabilize corrosive, reactive, toxic, ignitable or specifically listed hazardous chemicals. Much of this treated soil and water is scheduled for no economic or practical use, although it may be suitable for many uses. Resource enhancement at contaminated sites means taking a hazardous waste site, with its contaminated soil and water problems, and making the site location, soil excavation, aquifer restoration and soil and water treatment are favorable. Resource enhancement is technically, environmentally and economically viable at some sites. Cultural, institutional and public policy issues are currently constraints. Higher land and water uses are especially attractive, as they may offset cleanup costs. (See also W88-05724) (Author's abstract)
W88-05738

**COST AND PERFORMANCE EVALUATION FOR FULL SCALE, SINGLE SOLUTE CONTROL OF SYNTHETIC ORGANIC CHEMICALS BY GRANULAR ACTIVATED CARBON ADSORPTION,**
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
For primary bibliographic entry see Field 5F.
W88-05754

**EFFECT OF CONSERVATION TILLAGE ON PROCESSES AFFECTING NITROGEN MANAGEMENT,**
Agricultural Research Service, Lincoln, NE.
For primary bibliographic entry see Field 4C.
W88-05773

**MANURE MANAGEMENT WITH CONSERVATION TILLAGE,**
Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 4C.
W88-05774

**ASSESSMENT OF GREAT LAKES TILLAGE PRACTICES AND THEIR POTENTIAL IMPACT ON WATER QUALITY,**
Ohio State Univ., Columbus.
For primary bibliographic entry see Field 5C.
W88-05775

**STATE OF THE ENVIRONMENT: A VIEW TOWARD THE NINETIES.**
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 6G.
W88-05802

**STATE OF THE ENVIRONMENT: 1982.**
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 6G.
W88-05803

**ORGANIC CONTAMINANTS IN DRINKING WATER: WHAT, WHERE, WHEN AND HOW,**
Ontario Ministry of the Environment, Toronto. Water Resources Branch.
R. B. Hunsinger.
IN: Treatment of Drinking Water for Organic Contaminants. Proceedings of the Second National Conference on Drinking Water, Edmonton, Canada, April 7 and 8, 1986. Pergamon Press, New York. 1987. p 29-44, 7 fig, 3 ref, append.

Descriptors: *Organic compounds, *Drinking water, *Water quality control, *Data interpretation, Drinking Water Surveillance Program, Ontario, Water quality management, Data storage and retrieval, Detroit River, Case studies, St. Clair River.

The Drinking Water Surveillance Program (DWSP), developed by the Ontario Ministry of the Environment, is an assessment project based on standardized analytical and sampling protocol. DWSP is intended to compile current information on drinking water quality throughout Ontario, produce annual reports on results from each location, and alert appropriate regional personnel when water quality objectives are not fulfilled. The system allows for interrelation between in-plant, field and laboratory results, which helps put drinking water information in perspective. Outlined here are the major components of DWSP (input including: system description, field data, laboratory data, parameter reference file; and output: annual reports and action alerts) and how they operate. A working example of the capabilities of DWSP in response to the Detroit/St. Clair River emergency is given. (See also W88-05809) (Lantz-PTT)
W88-05813

**STATE OF THE ENVIRONMENT: AN ASSESSMENT AT MID-DECADE.**
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 6G.
W88-05846

**POLLUTION CONTROL IN THE PETROCHEMICALS INDUSTRY,**
Tennessee Technological Univ., Cookeville.
M. B. Borup, and E. J. Middlebrooks.
Lewis Publishers, Inc., Chelsea, Michigan. 1987. 180 p.

Descriptors: *Water pollution control, *Wastewater treatment, *Industrial wastes, *Petro-

leum products, *Oil wastes, *Chemical industry, Pollutant identification, Water pollution prevention, Costs, Economic aspects, Hazardous wastes, Energy, Process control, Standards, Wastewater facilities.

The petrochemicals industry is very complex and requires considerable knowledge of the individual processes to develop effective pollution control plans and processes. The characteristics of various waste streams are summarized, and a synopsis of treatment techniques and performances of these procedures is presented here. All aspects of pollution control, (air, water, solid wastes, hazardous wastes, and power consumption) are discussed. Processes used to treat petrochemical manufacturing plants' wastes are as varied as the processes used in the manufacturing plants themselves. Pollution control costs vary significantly, and the basic approach to pollution control will significantly affect costs. Great care must be exercised when selecting pollution control equipment. Guidelines for proper selection of pollution control equipment are presented throughout this book. (Lantz-PTT)
W88-05851

**EMPIRICAL METHODS FOR PREDICTING EUTROPHICATION IN IMPOUNDMENTS. REPORT 4: PHASE III, APPLICATIONS MANUAL,**
For primary bibliographic entry see Field 7C.
W88-05861

**STATISTICAL ASPECTS OF WATER QUALITY MONITORING.**
For primary bibliographic entry see Field 7C.
W88-05862

**ASSOCIATION OF CHLOROPHYLL A WITH PHYSICAL AND CHEMICAL FACTORS IN LAKE ONTARIO, 1967-1981,**
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 7A.
W88-05882

**DYNAMIC COVARIATE ADJUSTMENT OF WATER QUALITY PARAMETERS FOR STREAMFLOW: TRANSFER FUNCTION MODEL SELECTION,**
Vermont Univ., Burlington.
For primary bibliographic entry see Field 7C.
W88-05884

**ALTERNATIVES FOR IDENTIFYING STATISTICALLY SIGNIFICANT DIFFERENCES,**
For primary bibliographic entry see Field 7C.
W88-05886

**STATISTICAL ASSESSMENT OF A LIMNOLOGICAL DATA SET,**
Rensselaer Polytechnic Inst., Troy, NY.
For primary bibliographic entry see Field 7C.
W88-05889

**SPECTRAL ANALYSIS OF LONG-TERM WATER QUALITY RECORDS,**
Inland Waters Directorate, Vancouver (British Columbia). Pacific and Yukon Region.
P. H. Whitfield.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 388-403, 20 fig, 1 tab, 13 ref.

Descriptors: *Statistics, *Data interpretation, *Spectral analysis, *Water quality, *Data collection, *Vancouver, Capilano River, Seymour River, Coquitlam River, Hydrogen ion concentration, Turbidity, Water temperature.

The Greater Vancouver Regional District (GVRD) provides, along with other services, drinking water to the communities of Greater Vancouver. The total supply of water comes from three sources: the Capilano, Seymour and Coquitlam Rivers. As part of an extensive quality control program, the GVRD measures water temperature daily and pH and turbidity three to four times each week. These records commenced in 1959 and continue to the present. The records were reduced to weekly averages and examined in the frequency domain using spectral analysis. The frequency approach involves estimating how much of the variation in the data arises from various frequency bands. In analyzing the data, the application of spectral analysis as an aid to identify significant frequency components is examined. (See also W88-05862) (Author's abstract)
W88-05891

**ESTIMATION OF MONTHLY MEAN PHOSPHORUS LOADINGS,**
Waterloo Univ. (Ontario).
M. E. Thompson, and K. Bischoping.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 460-468, 2 tab, 8 ref.

Descriptors: *Phosphorus, *Niagara River, *Water quality, *Data interpretation, Correlation analysis, Statistical models, Time series analysis.

A study was conducted of estimation of monthly mean phosphorus loadings, using daily readings from the Niagara river for 1975-1982. Two alternatives to the current method of accounting for missing data are proposed from finite population sampling theory: (1) Estimators based on a zero correlation model for concentration; and (2) Estimators based on time series interpolation for concentration. In an empirical study, two months for which data were computed (March 1978 and November 1979) were used to evaluate the performance of the estimators. Both types of estimators were similar for both months. (See also W88-05862) (Lantz-PTT)
W88-05896

**STATE-BY-STATE ENVIRONMENTAL DATA SUMMARIES.**
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 6G.
W88-05900

**PROCESSES AFFECTING SUBSURFACE TRANSPORT OF LEAKING UNDERGROUND TANK FLUIDS,**
Nevada Univ., Reno. Desert Research Inst.
For primary bibliographic entry see Field 5B.
W88-05901

**AMERICA'S WATER: CURRENT TRENDS AND EMERGING ISSUES.**
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 6D.
W88-05913

**ENVIRONMENTAL AGENDA FOR THE FUTURE,**
Natural Resources Defense Council, Inc., Washington, DC.
For primary bibliographic entry see Field 6A.
W88-05915

**HAZARDOUS WASTE MANAGEMENT: REDUCING THE RISK,**
For primary bibliographic entry see Field 5E.
W88-05917

# 6. WATER RESOURCES PLANNING

## 6A. Techniques Of Planning

**DETERMINING THE LIKELIHOOD OF OBTAINING A RELIABLE MODEL,**
Texas Univ. at Dallas, Richardson. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5E.
W88-05169

**LINEAR PROGRAMMING APPROACH FOR MANAGING GROUNDWATER POLLUTION FROM PESTICIDES: A COMPARATIVE ANALYSIS OF ECONOMIC AND ENVIRONMENTAL RISK,**
Cornell Univ., Ithaca, NY. Graduate School.
For primary bibliographic entry see Field 5G.
W88-05212

**WATER RESOURCES PLANNING METHODOLOGY FOR WEST AFRICA,**
Northwestern Univ., Evanston, IL. Dept. of Civil Engineering.
M. L. Lumeh.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8621822. Ph.D Dissertation, 1986. 261 p, 18 fig, 40 tab, 183 ref, 3 append.

Descriptors: *Africa, *Water resources development, *River basin development, *Management planning, *Project planning, *Multiobjective planning, *Hydrologic models, Model studies, Computer models, Computer programs, Simulation analysis, Stochastic hydrology, Case studies.

A method was devised to appraise capital-intensive projects for water resources development in West Africa. The method provides a procedure for identifying resource potentials for development on a site-specific basis; determines the combinations of types of development projects that may be technically feasible for the available resources; and, for inadequate data, identifies the types and extent of data collection needed. A programming screening model for project selection and a simulation model for site specific analysis were developed. Multiobjective planning and hydrologic stochasticity techniques were applied. The methodology was tested using the Volta River Basin in Ghana as a case study area. The Volta project serves as a valuable reference source for future development in the region through more efficient use of resources (Cremmins-AEPCO)
W88-05215

**DESIGN AND EVALUATION METHODS FOR MAXIMIZING ON FARM EFFICIENCY OF CONVENTIONAL AND SURGE SURFACE IRRIGATION,**
Texas Univ., Austin. Center for Research in Water Resources.
For primary bibliographic entry see Field 3F.
W88-05232

**COMPARISON OF RESERVOIR LINEAR OPERATION RULES USING LINEAR AND DYNAMIC PROGRAMMING,**
Louisville Univ., KY. Dept. of Civil Engineering.
N. R. Bhaskar, and E. E. Whitlatch.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1027-1036, December 1987. 3 fig, 6 tab, 10 ref.

Descriptors: *Reservoir design, *Reservoir operation, *Optimization, *Mathematical studies, Reservoirs, Multipurpose reservoirs, Mathematical equations, Linear programming, Dynamic programming, Systems analysis, Hoover Reservoir, Ohio, Regression analysis, Reservoir releases, Simulation, Case studies, Comparison studies.

Mathematical optimization techniques are used to study the operation and design of a single, multipurpose reservoir system. Optimal monthly release policies are derived for Hoover Reservoir, located in Central Ohio, using chance-constrained linear programming and dynamic programming-regression methodologies. Important characteristics of the former approach are derived, discussed, and graphically illustrated using Hoover Reservoir as a case example. Simulation procedures are used to examine monthly reservoir release policies derived under the two approaches. Results indicate that,

for the mean detention time and the corresponding safe yield target water supply release under existing design of Hoover Reservoir, the dynamic programming policies produce lower average annual losses (as defined by a two-sided quadratic loss function) while achieving at least as high reliability levels when compared to policies derived under the chance-constrained linear programming method. In making this comparison, the reservoir release policies, although not identical, are assumed to be linear. This restricted form of the release policy is necessary to make the chance-constrained programming method mathematically tractable. (Author's abstract)
W88-05404

**RISK-BASED ANALYSIS OF EXTREME EVENTS,**
Virginia Univ., Charlottesville. Center for Risk Management of Engineering Systems.
P.-O. Karlsson, and Y. Y. Haimes.
Water Resources Research WRERAO, Vol. 24, No. 1, p 9-20, January 1988. 5 fig, 3 tab, 15 ref. NSF Grant ECE85-13445 and Oak Ridge National Laboratory Contract 41X-56529V.

Descriptors: *Decision making, *Public policy, *Risk-based analysis, *Statistics, Extreme events, Catastrophic events, Mathematical studies, Mathematical equations, Expected value function, Risks, Theoretical analysis.

Mathematical expectation has traditionally been used in solving risk-based decisionmaking problems. However, this concept is not appropriate for decisionmaking that affects public policy because it conceals extremes by commensurating events of different magnitudes and probabilities of occurrence. If a decisionmaker instead uses an expected value function in addition to a conditional expectation that captures extreme and catastrophic events, he will gain a more meaningful and more encompassing representation of the trade-offs at hand. A theory relating conditional expectation to the statistics of extremes is developed. This expectation can now be viewed as the conditional expected risk given the occurrence of an event with a return period that equals or exceeds n years. The theory highlights the importance of using both the conditional and the unconditional expected risk in decisionmaking. This fact has previously been recognized in the partitioned multiobjective risk method (PMRM), a risk analysis methodology based on the concept of conditional expectation. The theory now proposed provides a formulation for analyzing the sensitivity of subjectively chosen parameters in the PMRM. This theory will also simplify the practical implementation of the method. (Author's abstract)
W88-05525

**PROBABILITY DISTRIBUTIONS AND THEIR PARTITIONING,**
Virginia Univ., Charlottesville. Center for Risk Management of Engineering Systems.
P.-O. Karlsson, and Y. Y. Haimes.
Water Resources Research WRERAO, Vol. 24, No. 1, p 21-29, January 1988. 10 fig, 7 tab, 12 ref. NSF Grant ECE85-13445 and Oak Ridge National Laboratory Contract 41X-56529V.

Descriptors: *Probability distribution, *Decision making, *Partitioning, *Statistics, *Risk functions, Expected value function, Mathematical studies, Mathematical equations, Risk functions, Risks, Extreme events, Catastrophic events, Theoretical analysis, Probability distribution.

The partitioned multiobjective risk method (PMRM) was developed for solving risk-based multiobjective decisionmaking problems. Based on the premise that the expected value concept is not sufficient for proper decisionmaking, the PMRM generates a number of conditional expected value functions (or risk functions) by partitioning the probability axis into probability ranges. The goal of partitioning the probability axis is to have better information on extreme events for decisionmaking purposes. These conditional expectations are dependent on the chosen partitioning points. An analysis of how conditional expectations are sensitive to variations in partitioning is presented. One of the risk functions is a measure of extreme and catastrophic events. By using the relationship between this particular risk function and the statistics of extremes, the sensitivity analysis is simplified. In many practical applications, it is difficult to determine which type of distribution function best represents the random process. Conditional expectations also depend on the choice of distribution, and the impact of this selection is discussed. (Author's abstract)
W88-05526

**SITING MODEL FOR REGIONAL WASTEWATER TREATMENT SYSTEMS: THE CHAIN CONFIGURATION CASE,**
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
For primary bibliographic entry see Field 5D.
W88-05538

**COMPARATIVE ASPECTS OF COMPUTERIZED FLOODPLAIN DATA MANAGEMENT,**
Middlesex Polytechnic, London (England). School of Geography and Planning.
E. C. Penning-Rowsell, J. B. Chatterton, H. J. Day, D. T. Ford, and M. A. Greenaway.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 6, p 725-744, November, 1987. 7 fig, 1 tab, 69 ref, 1 append.

Descriptors: *Flood plain management, *Automation, *Data storage and retrieval, *Data processing, *Flood control, *Management planning, Planning, Flood plains, Australia, United Kingdom, United States, Computers, Administrative agencies, Administrative decisions, Policy making, Standards, Flood damage.

The evolving floodplain management policies in Australia, the United Kingdom, and the United States are reviewed and compared. In each country, computerized floodplain information processing and retrieval systems have been designed for evaluating flood mitigation schemes. However, the information systems differ in detail and reflect the different aims and objectives of the organizations from which they have originated. Nevertheless, the general trend within each country is for national standardization of methodologies to promote consistent floodplain management. The following are among the systems discussed: the U.S. Army Corps of Engineers Hydrologic Engineering Center Spatial Analysis Package and Storage System (HEC-SAM), the Severn-Trent Water Authority Data Collection and River Management System, the Middlesex Polytechnic Damage Assessment System, and the Australian National University Flood Damage Programs, including ANUFLOOD. (Author's abstract)
W88-05611

**REAL-TIME FLOOD MANAGEMENT MODEL FOR HIGHLAND LAKE SYSTEM,**
Texas Univ., Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W88-05638

**WATER RESOURCES ANALYSIS USING ELECTRONIC SPREADSHEETS,**
Southwest Florida Water Management District, Brooksville.
For primary bibliographic entry see Field 7C.
W88-05639

**PROJECTING STORAGE IN HIGHLAND LAKE RESERVOIR SYSTEM,**
HDR Infrastructure, Inc., Austin, TX.
For primary bibliographic entry see Field 3B.
W88-05640

**HIERARCHICAL ALGORITHM FOR WATER SUPPLY EXPANSION,**
Lower Colorado River Authority, Austin, TX. Water Policy and Programs Div.
Q. W. Martin.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 5, p 677-695, September, 1987. 5 fig, 35 ref, 1 append.

Descriptors: *Algorithms, *Water supply development, *Regional planning, *Systems analysis, *Operating costs, *Computers, Dynamic programming, Water resources development, Planning, Simulation, Basins, River basins, Reservoirs, Water supply, Optimization, Economic aspects, Pipelines, Costs, Automation.

A computational method is described for finding the approximate optimal capacity expansion plan for a surface-water supply system. The algorithm determines the estimated least-costly sizing, sequencing, and operation of surface-water storage and conveyance facilities over a specified set of staging periods. The expansion problem is separated into capital investment and system operation subproblems. A dynamic programming (DP) algorithm computes the least-costly capital investment plan, where the optimal operating costs are approximated for each feasible set of projects. Development plans at each stage are then analyzed using a coupled set of network optimization models to compute actual system operating costs. These optimal operating costs are used to update the estimated minimum system costs. When an expansion plan is obtained by DP, which has the true operating costs, then the estimated minimum-cost policy has been found. This approximate optimal plan is the true optimum if evaporation differences between reservoirs are insignificant. The algorithm is applied to the Guadalupe and San Antonio river basins in Texas to demonstrate its use in regional planning. (Author's abstract)
W88-05641

**EFFECTS OF UNCERTAINTIES ON OPTIMAL RISK-BASED DESIGN OF HYDRAULIC STRUCTURES,**
Wyoming Water Research Center, Laramie.
Y.-K. Tung.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 5, p 709-722, September, 1987. 5 fig, 6 tab, 30 ref, 1 append.

Descriptors: *Hydraulic structures, *Optimization, *Risks, *Risk-based design, *Mathematical studies, *Statistical analysis, *Design criteria, *Leaves, Distribution, Frequency distribution, Economic aspects, Costs, Forecasting, Flood forecasting.

The effect of inherent hydrologic and parameter uncertainties, as well as hydraulic uncertainty, on the optimal risk-based design of hydraulic structures was examined through an example of levee system design. The hydrologic parameter uncertainty is represented by a sampling distribution of the flood magnitude estimator; this has the advantage of keeping the necessary mathematical manipulation to a minimum while taking into account the combined effect of all parameter uncertainties in flood frequency analysis. Considering hydrologic inherent and parameter uncertainties as well as hydraulic uncertainty requires at most a triple integration. Numerical results obtained using the optimal levee design as an example indicate that the optimal size of a hydraulic structure would increase as more uncertainties are considered in the analysis. Design practices that do not consider any hydrologic or hydraulic uncertainty are unacceptable for most situations. The conventional risk-based approach that considers only hydrologic inherent randomness might still not be enough to reach the optimal solution to the design problem if hydrologic parameter uncertainty, hydraulic uncertainty, or both are not considered. (Doria-PTT)
W88-05643

**RISK ASSESSMENT AND RISK CONTROL.**
Conservation Foundation, Washington, DC.
The Conservation Foundation, Washington, DC. 1985. 69 p.

Descriptors: *Risks, *Project planning, *Probabilistic process, *Data interpretation, *Probability distribution, Evaluation, Hazards, Environmental effects, Liability, Mathematical models, Mathematical studies, Legal aspects, Public health.

Government today is being asked to control many risks that are often difficult to assess. This task is often complicated by the inadequacy of data and scientific knowledge that plagues almost all risk assessments. This report examines how government agencies determine the adverse environmental consequences that could result from the use of a technology or some other action. Risk assessment typically includes three different elements: an estimate of the probability of a hazard occurring; a determination of the types of hazard posed; and an estimate of the number of people, wildlife, or other environmental elements likely to be impacted by the hazard. An example of risk assessment associated with floods and droughts is given. The report also describes how policy or personal values inevitably enter into the risk-assessment process and how more data and better scientific knowledge would significantly improve the ability to assess risks. While billions of dollars are being invested by government at all levels and by business to comply with environmental standards, comparatively little is being invested to improve the scientific basis for the standards. An improvement in risk assessment would be a major step in ensuring that compliance money is well spent. (Geiger-PTT)
W88-05689

**CITIZEN'S GUIDE TO RIVER CONSERVATION,**
National Park Service, Boston, MA.
R. Diamant, J. G. Eugster, and C. J. Duerksen.
The Conservation Foundation, Washington, DC. 1984. 113 p.

Descriptors: *Water conservation, *Public participation, *Recreation, *Rivers, *Environmental protection, *Management planning, Project planning, Minimum flow, Dam effects, Environmental effects, Water pollution effects, Recreation facilities, Land use, River regulations, Resources management.

This guide is intended to encourage and help anyone, regardless of experience, to organize an effective river conservation program. It emphasizes building multi-interest citizen coalitions through community involvement in river and stream conservation efforts, discusses both practical steps for citizen action and conservation tools used effectively throughout the country, from land trusts to easements to regulatory strategies. Case studies are included of innovative programs that suggest how concerned citizens, working together, can positively influence the future of their local rivers and waterways through land and water conservation. Chapters focus on the following topics: guidelines for getting started; understanding the issues of water projects, diversion and minimum flow, pollution, shoreline development and recreation; using basic conservation tools; and choosing a strategy for river conservation projects. Appendices give information on National Park Service regional offices, national river conservation organizations, state river program managers, case-study program managers, national wild and scenic rivers, major federal laws and executive orders applicable to river conservation, and measuring the values of river conservation. (Geiger-PTT)
W88-05690

**IRRIGATION DEVELOPMENT PLANNING: AN INTRODUCTION FOR ENGINEERS,**
John Wiley and Sons, New York, New York. 1987. 265 p. Edited by J. R. Rydzewski.

Descriptors: *Irrigation programs, *Management planning, *Agricultural practices, *Water resources development, Land resources, Irrigation engineering, Irrigation operation.

The various factors which must be considered whenever an irrigation project is planned are discussed. The aim is to provide irrigation engineers with a guide to the process of project planning and formulation so that their design decisions can form an integral part of the search for an optimal solution to any particular problem. Topics cover the assessment of the water, land and human resources involved in irrigation development, as well as the consideration of project formulation and appraisal, and the presentation of development proposals. (See W88-05832 thru W88-05842) (Lantz-PTT)
W88-05831

**INTRODUCTION: PLANNING OF IRRIGATION DEVELOPMENT,**
Southampton Univ. (England). Inst. of Irrigation Studies.
J. R. Rydzewski.
IN: Irrigation Development Planning: An Introduction for Engineers. John Wiley and Sons, New York, New York. 1987. p 1-10, 1 tab, 5 ref.

Descriptors: *Management planning, *Irrigation programs, *Water resources development, Economic aspects, Irrigation engineering, Public policy, Taxes, Monitoring, Feasibility studies, Local governments.

Irrigated agriculture can be seen as a special case of intensive agriculture, in which technology intervenes to provide control for the soil-moisture regime in the crop root zone. The aim is to achieve a high standard of year-round agriculture, irrespective of rainfall availability. The manner in which technology intervenes can be: (1) to add water when it is needed by the crops; (2) to remove excess water from the soil profile; (3) to remove excess water from the surface of the cropped land; and (4) to protect the cropped land from flooding (from higher lands and from adjoining rivers). The extent to which the various water management practices come into play depends on the climatic and physical conditions. In arid areas the addition of water for crop consumption and soil leaching would dominate, while in areas with seasons of heavy storms and long dry spells all the functions listed would be important. The scale of development can range from millions of hectares on the Indo-Gangetic Plain to a farmer and his well on a couple of hectares. Since various national and international bodies may become involved in the creation of a project, it has proved useful to distinguish between the major stages of the process, so that the extent of participation by various disciplines, and their responsibilities, become clearer. The stages are: (1) identification and pre-feasibility studies; (2) feasibility studies (project preparation for funding); (3) implementation; and (4) monitoring and evaluation. A project is likely to comprise some or all of the following five elements: (1) Capital investment in engineering works and equipment; (2) Provision of services for engineering design, for supervision of implementation and for operation and maintenance; (3) Strengthening of local institutions concerned with implementing and operating the project, including the training of local personnel; (4) Improvement in policies (e.g. on pricing, taxes, subsidies, etc). that may affect project performance; and (5) A plan for implementing the above four activities to achieve the project objectives within the specified time. (See also W88-05831) (Lantz-PTT)
W88-05832

**ESTIMATION OF SURFACE WATER RESOURCES,**
P. R. Helliwell.
IN: Irrigation Development Planning: An Introduction for Engineers. John Wiley and Sons, New York, New York. 1987. p 11-37, 11 fig, 46 ref.

Descriptors: *Water resources development, *Data acquisition, Evaluation, Data interpretation, Soil water, Precipitation, Mathematical analysis, River flow, Catchment yield, Hydrologic budget.

A clear understanding of hydrological principles is essential to the planning of irrigation development. Where hydrological predictions are uncertain for any reason, development must be staged in such a way that a later downward revision of available water resources will not ruin the scheme. Shortage of good quality data is the primary problem encountered in water resource assessment. Usually data are absent, of unknown quality, or fragmentary. In many cases art as well as science is needed in preparation of estimates. An outline of a general plan of attack on the problem is as follows: (1) Seek out data on climate, rainfall and river flow from the project area and from surrounding areas, including neighboring countries; (2) Initiate immediately a hydrometric program to start to make good deficiencies in existing data; (3) Attempt to assess river flow parameters, either directly or indirectly; (4) Look for evidence of long dry periods, either in the data or from general evidence and local knowledge; (5) Assess potential yield without storage; (6) Assess potential yield with storage; (7) Check water quality, particularly during low flows. Data collection includes: current meters for river flow; rain gauges for precipitation; background radiation evaluation for climate assessment; evaporation measurement and estimation; soil moisture meters for determining soil water; and catchment yields to tie together the 5 previous values. (See also W88-05831) (Lantz-PTT)
W88-05833

**LAND RESOURCE ASSESSMENT FOR IRRIGATION,**
Land Resources Development Centre, Surbiton (England).
For primary bibliographic entry see Field 3F.
W88-05835

**FEASIBILITY REPORT,**
Halcrow (William) and Partners, Swindon (England).
C. L. Clarke, and J. Anderson.
IN: Irrigation Development Planning: An Introduction for Engineers. John Wiley and Sons, New York, New York. 1987. p 239-260, 5 fig, 1 ref.

Descriptors: *Management planning, *Feasibility studies, *Irrigation programs, *Water resources development, Performance evaluation, Economic aspects, Water supply, Agricultural practices, Public opinion, Social aspects, Resource allocation, Resources management.

The major decisions on any large development are made following study of the feasibility report, which defines the benefits to be expected and estimates the cost. The purpose of the feasibility report is to define in detail the necessary scope of the project, to assess the practicability of development and, in doing so, the findings are normally used to: (1) compare the development with other possible developments in the same country or region so that priorities can be given to the better projects and the best use made of limited resources; (2) decide if the development is worth while; and (3) initiate arrangements for implementation, particularly finance and design. Although normally a major portion of irrigation development costs do lie in the civil works, it must be appreciated that the ultimate success of a scheme depends on an integrated approach which considers all aspects (e.g. agriculture, human resources, environment, etc.). The study must show that in all respects the scheme is feasible. The processes involved in the production of a feasibility report are considered. The general layout of the report is discussed and attention is drawn to the essential features of the various investigations including the composition of the study teams, integration of specialist groups, collection and analysis of main data (topography, ground investigations, water resources investigations), agricultural practices and marketing, engineering, social, political and environmental features. The management of the completed project and the training of management and operational personnel are also discussed. (See also W88-05831) Lantz-PTT)
W88-05842

**MANAGING HAZARDOUS WASTES: A PROGRAMMATIC APPROACH,**
Council of State Governments, Lexington, KY.
For primary bibliographic entry see Field 5E.
W88-05844

**ENVIRONMENTAL AGENDA FOR THE FUTURE,**
Natural Resources Defense Council, Inc., Washington, DC.
J. H. Adams, L. C. Dunlap, J. D. Hair, F. D.

Krupp, and J. Lorenz.
Island Press, Washington, DC. 1985. 155 p.

Descriptors: *Management planning, *Environmental protection, *Water resources development, Public policy, Interagency cooperation, Population dynamics, Water pollution control, Hazardous wastes, Agriculture, Energy, Environmental effects.

The key to the solution of most of the problems raised in this agenda (nuclear issues, human population growth, energy strategies, water resources, toxics and pollution control, wild living resources, private lands and agriculture, protected land systems, public lands, and urban environments) for the future is public awareness of the issues and a recognition of the interconnections among population growth, natural resource availability, development, and environmental impacts. The general public and decision-makers need to understand the true costs of their own actions and those of government and the private sector and how to weigh the long-term, far-reaching benefits against the immediate, localized costs for risks. Any consideration of the future must remain dynamic. Hence this agenda will be subjected to periodic review and revision as trends and circumstances require. The individual chapters on specific issues are written with the intent of highlighting some of the environmental problems that are expected to command attention in the coming years while also discussing some of today's highest priorities, which will affect the future. (Lantz-PTT)
W88-05915

## 6B. Evaluation Process

**WATER AND DEVELOPMENT: A COMPLEX RELATIONSHIP,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6E.
W88-05155

**METHOD FOR IDENTIFYING WATER RESOURCES RESEARCH NEEDS AND SETTING PRIORITIES AMONG THEM,**
Vanderbilt Univ., Nashville, TN. Dept. of Environmental and Water Resources Engineering.
W. F. Brandes.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8616341. Ph.D Dissertation, 1986. 399 p, 21 fig, 12 tab, 169 ref, 5 append.

Descriptors: *Water resources research, *Planning, *Research priorities, *Water resources development, *Priorities, State jurisdiction, Surveys, Conferences, Literature review.

The process of identifying water resources research needs and establishing priorities among them were studied based on the design of a water resources research agenda for the State of Tennessee. The literature was reviewed, conferences were held, a survey was conducted, interviews were completed, and prioritizing methods were applied. A method was developed that could be used effectively to establish water resources research agendas for states and possibly other entities. The method attracted sustained interest and support from over 50 professionals or others intimately involved in water resources matters. The Tennessee Water Resources Research Center used the projects identified by this investigation as the basis for its annual programs for three years in succession. The method is time-consuming and expensive, but does not promote communication and interest in water resources research throughout the community of users and researchers in the State. (Cremmins-AEPCO)
W88-05201

**USE OF A DYNAMIC PROGRAMMING TECHNIQUE FOR OPTIMIZING OPERATION OF A REGIONAL WATER RESOURCE SYSTEM,**
North West Water Authority, Warrington (England).
For primary bibliographic entry see Field 5F.
W88-05280

**RISK-BASED ANALYSIS OF EXTREME EVENTS,**
Virginia Univ., Charlottesville. Center for Risk Management of Engineering Systems.
For primary bibliographic entry see Field 6A.
W88-05525

**PROBABILITY DISTRIBUTIONS AND THEIR PARTITIONING,**
Virginia Univ., Charlottesville. Center for Risk Management of Engineering Systems.
For primary bibliographic entry see Field 6A.
W88-05526

**EVALUATION AND SCHEDULING OF WATER CONSERVATION,**
California Univ., Davis. Dept. of Civil Engineering.
J. R. Lund.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 5, p 696-708, September, 1987. 1 fig, 2 tab, 18 ref, 1 append.

Descriptors: *Water conservation, *Scheduling, *Linear programming, *Economic aspects, *Planning, Conservation, Costs, Evaluation, Construction costs, Operating costs, Water demand, Water shortage, Sensitivity analysis, Cost-benefit analysis.

A linear programming method is suggested for evaluating and scheduling of water conservation measures for deferring or avoiding a single anticipated capacity expansion project. The method is contrasted with long-run marginal cost techniques and demonstrated for the case of a small city contemplating conservation to defer a water treatment plant expansion alternative. The least-cost conservation schedule is found by running a small set of linear programs. The sensitivity of this result to changes in capacity costs, conservation costs, and capacity is found using the initial set of linear program results. Uncertainty is water use and demand forecasts and real interest rates requires solving additional linear programs. The conservation schedule is updated easily, as improved use and cost forecasts become available, by solving additional linear programs periodically throughout the conservation schedule. The linear programming method is also a general solution method encompassing simpler special cases where capacity constraints are either imminent or nonexistent. (Doria-PTT)
W88-05642

**RISK ASSESSMENT AND RISK CONTROL.**
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 6A.
W88-05689

**SETTLING THINGS: SIX CASE STUDIES IN ENVIRONMENTAL MEDIATION,**
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 6E.
W88-05693

**GUIDELINES FOR PLANNING COMMUNITY PARTICIPATION ACTIVITIES IN WATER SUPPLY AND SANITATION PROJECTS,**
Toronto Univ. (Ontario). Inst. for Environmental Studies.
A. Whyte.
World Health Organization, Geneva, Switzerland. WHO Offset Publication No. 96, 1986. 53 p, 2 fig, 9 ref.

Descriptors: *Water supply, *Standards, *Water quality management, *Public participation, Community development, Public policy, Economic aspects, Management planning.

It is now recognized that in water supply and sanitation projects, best results are obtained only when the communities participate in the planning and execution of projects and when other sectors contribute simultaneously to the development effort. Such community participation and intersectoral activities must be planned in great detail, with real, rather than hoped-for, financial and manpower resources committed to them from the outset. The guidelines for planning presented in this book, draw attention to the 'what, when, where, why, how, and who' questions associated with community participation; the material presented in the form of check-lists of points to consider. The topics covered include: assessment of a community's potential for participation; setting of program objectives and priorities; planning for national and regional agency support to communities; planning programme details at the community and project levels; and evaluation of activities. (Lantz-PTT)
W88-05698

**STANDARD MODEL DESIGNS FOR RURAL WATER SUPPLIES.**
World Health Organization, Copenhagen (Denmark). Regional Office for Europe.
For primary bibliographic entry see Field 8A.
W88-05702

**POLICIES RELATING TO GROUNDWATER AND BIOFOULING,**
Environmental Protection Agency, Atlanta, GA. Region IV.
For primary bibliographic entry see Field 6E.
W88-05725

**SOCIAL ASPECTS OF IRRIGATION DEVELOPMENT,**
Southampton Univ. (England). Inst. of Irrigation Studies.
E. D. Gordon.
IN: Irrigation Development Planning: An Introduction for Engineers. John Wiley and Sons, New York, New York. 1987. p 161-176, 2 tab, 13 ref.

Descriptors: *Social aspects, *Irrigation programs, *Water resources development, Public participation, Agriculture, Political aspects.

There is increasing recognition that irrigated agricultural development must be visualized in its total environment, taking a long and wide view of the whole rural system. This indicates: (1) The elements of a plan should form a complete set consistent with local conditions, and because of the innovative aspect include special provision for extension and training; (2) A number of consequential adjustments to the rural system are needed, especially with regard to the 'output delivery system' - marketing, etc. - and the 'institutions' - ways of cooperation, incentives, administration and staff management; and (3) Because of uncertainty and the complexity of the systems it can never be ensured that things will go as planned. Therefore there should be phased implementation, there must be a feedback system to respond and adapt (management requires an involvement and awareness in the political structure.) This is not to suggest that one has to await conclusive research findings on all questions. The art is to make the right decisions on incomplete evidence. (See also W88-05831) Lantz-PTT)
W88-05838

**IRRIGATION PROJECT APPRAISAL,**
Southampton Univ. (England). Inst. of Irrigation Studies.
J. R. Rydzewski.
IN: Irrigation Development Planning: An Introduction for Engineers. John Wiley and Sons, New York, New York. 1987. p 201-227, 1 fig, 7 tab, 11 ref.

Descriptors: *Irrigation programs, *Performance evaluation, *Planning, Economic aspects, Social aspects, Political aspects, Agriculture.

Project appraisal has two distinct but related functions: (1) to assist the planner-designer in selecting viable project proposals from within a set of technically sound alternatives in a particular sector of the economy; and (2) to allow central planners to

make rational decisions between projects in different sectors of the economy, and between mutually exclusive proposals in any given sector. An irrigation project proposal can be viewed critically (i.e. appraised) from several standpoints: (1) that of the central planning organization (or equivalent) with its wish to optimize the allocation of scarce resources within the economy and to achieve certain set planning targets; (2) that of the government or regional socio-political organs who, in the broadest sense, wish to improve the conditions of the people and of the environment; (3) that of the farmers who form the basic operational unit of many projects in the public sector; (4) that of management in public-sector projects who need a secure flow of appropriate resources (notably financial) to meet the day-to-day needs of the project; and (5) that of the entrepreneur, if encouraged to invest capital in the project. The analysis will differ in each case, especially in the way it values the inputs and outputs of the project. The first two points affect the initial decision of whether to embark on the project or not. The last three will indicate how attractive the project will be to those actually operating it and, therefore, on how likely it is to become a viable reality. However, the basic data for all five points are to a large extent common, but require modification and different organization for each purpose (financial, economic or social). (See also W88-05831) Lantz-PTT)
W88-05840

**IMPORTANCE OF DESIGN QUALITY CONTROL TO A NATIONAL MONITORING PROGRAM,**
Inland Waters Directorate, Ottawa (Ontario).
For primary bibliographic entry see Field 7A.
W88-05869

## 6C. Cost Allocation, Cost Sharing, Pricing/Repayment

**FARM AND WATERSHED ECONOMIC IMPACTS OF AGRICULTURAL POLICY. APPROACHES TO REDUCE SOIL EROSION AND SEDIMENTATION,**
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
M. B. Sands.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8701607. Ph.D Dissertation, 1986. 213 p, 13 fig, 38 tab, 57 ref, append.

Descriptors: *Public policy, *Soil erosion, *Sedimentation, *Economic aspects, *Farm management, Watersheds, Agricultural watersheds, Model studies, Policy making, Crop production, Soil conservation, Optimization, Linear programming.

Public policies for controlling soil losses from agricultural cropland were studied in terms of net return above land costs for crop production; changes in cropping practices, such as tillage methods, conservation practices, and crop rotation; and offsite sediment damages. A watershed that was subdivided into hypothetical farm units was represented in an optimizing linear programming framework. The policies evaluated resulted in lower erosion rates and reduced offsite damages, but at a cost of reduced revenues or increased public expenditures. Restrictive soil loss constraints encouraged shift in production practices in order of impact on net returns. Tillage practices changed from conventional to the more soil conserving plow-plant and chisel plow, followed by adoption of contouring and terracing. Crop activities shifted from intensive row crops to rotations. Soil loss restrictions forced larger production adjustments on less productive, more erosion prone farms. When sediment delivery was restricted, a location advantage was conferred on farms in close proximity to a reservoir. Offsite damages were a significant determinant of the optimal combination of watershed cropping and conservation practices. The subsidy policies evaluated were generally less efficient than regulatory policies in achieving soil loss targets. (Cremmins-AEPCO)
W88-05199

**LINEAR PROGRAMMING APPROACH FOR MANAGING GROUNDWATER POLLUTION FROM PESTICIDES: A COMPARATIVE ANALYSIS OF ECONOMIC AND ENVIRONMENTAL RISK,**
Cornell Univ., Ithaca, NY. Graduate School.
For primary bibliographic entry see Field 5G.
W88-05212

**EVALUATING ALTERNATIVE COAGULANTS TO DETERMINE EFFICIENCY AND COST EFFECTIVENESS,**
Philadelphia Water Dept., PA.
For primary bibliographic entry see Field 5F.
W88-05331

**FEASIBILITY OF SEASONAL WATER PRICING CONSIDERING METERING COSTS,**
Nevada Univ., Reno. Dept. of Agricultural Economics.
R. Narayanan, H. Beladi, R. D. Hansen, and A. B. Bishop.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1091-1099, December 1987. 4 fig, 4 tab, 15 ref.

Descriptors: *Seasonal pricing, *Water supply, *Pricing, *Economic aspects, Optimization, Mathematical models, Salt Lake City, Case studies, Feasibility studies, Seasonal variation, Water rates, Water metering.

Efficiency implications of seasonal pricing, uniform pricing, and optimal seasonal pricing with metering costs were analyzed qualitatively using classical optimization techniques. A nonlinear-integer programming model was formulated for a case study application to Salt Lake City to examine the feasibility of seasonal pricing. The analysis indicates that uniform pricing is preferable unless metering costs are substantially lower than present levels. At the present costs of metering, an annual uniform price of $253/MG would have been optimal in 1975 and should increase as demand grows over time to $270/MG in 1990 (a 37% increase is assumed). The price should increase to $271/MG by 2010 (A 76% demand growth is assumed). (Wood-PTT)
W88-05412

**AGGREGATE MARGINAL RETURNS FROM WESTERN IRRIGATED AGRICULTURE,**
Idaho Univ., Moscow. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6D.
W88-05415

**WATER FOR ALL-WHO PAYS,**
World Health Organization, Geneva (Switzterland). Community Water Supply and Sanitation Unit.
L. Laugeri.
World Health Forum WHFODN, Vol. 8, No. 4, p 453-460, 1987.

Descriptors: *Cost allocation, *Water distribution, *Water costs, *Prices, Economic aspects, Cost sharing, Drinking water, Water supply, Cost effectiveness, Water use, Developing countries, Capital costs.

Distribution of water costs among consumers is often uneven, with the poor often paying up to 10 times the average price in spite of poor service. At least 9/10 of the cost of drinking water are accounted for by depreciation, supplies, wages, and debt servicing, but these categories are rarely included in the present price of water. This results in a continual shortage of capital funds for expansion and operation. Unit costs are not likely to decrease. Competition for supplying water service is often nonexistent, and the consumer has no alternative source. Thus prices can be fixed higher than current operating costs to provide money for expansion. Factors which drive up the price of water are use of technology too complex for needs, lack of local competition in building waterworks, and vested interests from loaning institutions. Demand for water service in the poor sections of rapidly developing cities outstrips the ability of the few large consumers to help subsidize development. Better control of the illegal water sellers by licensing can reduce the price to consumers. This is often preferable because in many communities the municipal services are imperfect and corrupt. One successful way of supplying water is to establish a drinking water fountain in a central place and run it as a small business. Abuses may be minimized by setting a ceiling price and by proper recordkeeping. Waste of water must be curbed in the private sector. The principle of applying a charge to all users, even the poor, has some advantages in discouraging waste and excessive consumption. However, a sliding scale should be developed so that the poor do not pay more than 5% of their incomes for water. (Cassar-PTT)
W88-05493

**FEDERAL RECLAMATION PROGRAM: AN ANALYSIS OF RENT-SEEKING BEHAVIOR,**
Washington Univ., Seattle. Dept. of Economics.
For primary bibliographic entry see Field 6E.
W88-05681

**WATER PRICING AND RENT SEEKING IN CALIFORNIA AGRICULTURE,**
California Univ., Davis. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6E.
W88-05682

**WATER IN COLORADO: FEAR AND LOATHING OF THE MARKETPLACE,**
For primary bibliographic entry see Field 6E.
W88-05683

**BUILDING MARKETS FOR TRADABLE POLLUTION RIGHTS,**
Clemson Univ., SC. Dept. of Economics.
For primary bibliographic entry see Field 6E.
W88-05688

**PILOT PLANT TREATMENT TECHNIQUES FOR TRIHALOMETHANE PRECURSOR REDUCTION - SOME FINANCIAL IMPLICATIONS,**
Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W88-05819

## 6D. Water Demand

**HARBOR REVIVED,**
Warzyn Engineering, Inc., Madison, WI.
For primary bibliographic entry see Field 8A.
W88-05128

**SIZING OF TERMINAL UNITS IN SURFACE IRRIGATION PROJECTS: II,**
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W88-05151

**POTENTIAL HYDROENERGY PRODUCTION BY OPTIMIZATION,**
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
S. P. Simonovic, and L. M. Miloradov.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 114, No. 1, p 101-107, January 1988. 2 fig, 2 tab, 9 ref.

Descriptors: *Hydroelectric power, *Optimization, *Water resources development, *Yugoslavia, Water demand, Hydroelectric plants, Reservoirs, Energy, Economic aspects.

The North Backa hydrosystem is located in the northern part of Yugoslavia and is bounded by the River Tisza on the eastern side, the Yugoslavian and Hungarian borders on the north, and the canals of the hydrosystem Danube-Tisza-Danube

on the west and south. The hydrosystem covers 983,000 acres (398,000 ha) of very good agricultural land. However, there is a shortage of water. The potential water supplies of this region contains a number of very small rivers (Plazovic, Mostonga, Krivaja, Cik, and Keres) with a limited amount of water, around 16,000 acre-ft/hr. The water supply problem of the North Backa region has been studied since 1975 and the main purpose of all the studies has been to find a technical solution for providing water so as to satisfy the water demand in the region. All the alternative solutions suggested that water should be taken from the River Tisza and that a system of reservoirs should be built on the Rivers Cik and Krivaja. The system would include a number of canals and pumping stations for transporting water. During the study period, an analysis was done of alternative system configurations that differed in details. From the optimization results, it can be concluded that the North Backa hydrosystem designed for water supply purposes can only produce 1,708 MWh of electrical energy per annum. However, the energy consumption of the system is much higher and goes up to 27,057 MWh per year. Therefore, with the proposed number of hydroelectric plants, it is possible to save about 6.31% of the yearly energy consumption. Nevertheless, in order to make a final conclusion regarding the acceptance of the proposed solution, a very detailed economic study must be made. This study should represent the trade-off between the energy production on one hand and investment and operation and maintenance costs for the proposed hydroelectric plants on the other hand. Since the region under consideration has few energy resources, the final conclusion regarding the acceptance of proposed energy production purposes of the system may change. (Alexander-PTT)
W88-05156

**MAJOR WATER RESOURCE PROBLEMS AND PROJECTS IN CHINA,**
Chengdu Univ. of Science and Technology (China). Dept. of Hydraulic Engineering.
H. Yuguang, and W. Chu.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 114, No. 1, p 108-114, January 1988. 4 fig, 5 ref.

Descriptors: *Water resources development, *Groundwater, *China, *Reservoirs, *Basins, Water distribution, Dams, Engineering, Financing, Watersheds, Diversion.

Because of severe surface water shortages in China groundwater pumpage is common in urban (domestic and industrial uses) as well as rural (agricultural use) communities. Excessive pumping of groundwater in the North has recently caused serious damage. The development of effective solutions to the water shortage problem in the North is the biggest challenge to Chinese water resources engineers and planners in the years to come. Moving toward mitigation of some of these problems, the Chinese government has invoked a number of ambitious projects in nearly all river basins. Two of the most significant projects are presented. The proposed Central Route entails diversion of water from the proposed Three Gorge Reservoir through Danjiang Divide, and then siphoning underneath the Yellow River to the north. Further planning for the Central Route is contingent upon the completion of the Three Gorge Project. The engineering and environmental challenges for the central route are much greater than those for the east route. The plan for a western route is even more ambitious. The water in the upstream watershed of Changjiang will be stored in a series of high dams and then lifted across the divide and over to the upstream watershed of the Yellow River. The plan will be most effective in solving the water shortage problem in the north because excess water will be available for both the northwest region and the northern provinces. The problems of the plan are the enormous engineering (and financing) work of constructing the series of high dams and pumping stations in the remote (some still inaccessible) mountainous area along the route. It is expected that further planning of this route will be conducted well into the twenty-first century. (Alexander-PTT)
W88-05157

**INTEGRATING DEMAND MANAGEMENT OF URBAN REGIONAL WATER SYSTEMS: A CANADIAN CASE STUDY AND IMPLICATIONS,**
Michigan Univ., Ann Arbor.
J. E. Robinson.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 870817. Ph.D Dissertation, 1986. 191 p, 9 fig, 14 tab, 73 ref.

Descriptors: *Water demand, *Water supply, *Case studies, *Decision making, *Management planning, *Urban planning, Water treatment, Wastewater management, Regional planning, Water use, Municipal water, Municipal wastewater.

Water demand management in an urban regional water system was investigated based on a case study of the Regional Municipality of Waterloo. The case study includes elements of action research or 'reflection-in-action.' Decisions made using integrated demand and supply management are compared with those made using supply management alone. Through integrated water system management, the system itself would become more efficient and less expensive to operate; longer-term expansion of use could occur with existing supplies of water and wastewater treatment; and short-term supply shortfalls would be alleviated. Obstacles to integrated water management are related to regional equity versus efficiency, the belief that water creates wealth, the historical low cost of supplies, the belief that managing demands is for water-short areas, institutional biases within water supply agencies, and the institutional separation of water subsystem management. More comprehensive management requires additional resources for more sophisticated data collection and analysis and for management salaries. Such resources may be justified in large municipalities, those experiencing rapid growth, or those facing a major capital program, but may improve decisions very little in others. (Cremmins-AEPCO)
W88-05206

**METROPOLITAN WATER SUPPLY SYSTEM OPTIMIZATION FOR WATER ALLOCATION DURING DROUGHT IN SALT LAKE COUNTY,**
Utah State Univ., Logan. Coll. of Engineering.
G. B. Song.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8619389. Ph.D Dissertation, 1986. 379 p, 25 fig, 94 tab, 123 ref, 3 append.

Descriptors: *Drought, *Water supply, *Model studies, *Metropolitan water management, *Hydrologic data, Water management, Water conservation, Water use, Social costs, Stochastic hydrology, Water shortage, Water loss, Optimization.

A model was developed for determining an optimal short-term water management policy for Salt Lake County, Utah during drought years using representations of hydrologic interactions among water users and user differences in marginal value received per unit of water used. Data were derived for assessing the social difficulties in promoting different water conservation practices in adjacent service areas, and the institutional difficulties in establishing equitable water allocation when some, but not all communities, have invested in drought protection. Stochastic hydrology was used to optimize water allocations by minimizing the sum of economic losses dye to water shortfall and costs of providing supplemental water. The monthly economic losses and costs in a drought year by small use area were explicitly estimated while minimizing a nonlinear objective function which would otherwise, without surplus variables, be neither smooth nor continuous and hence not solvable using the computer program MINOS. (Cremmins-AEPCO)
W88-05219

**INTERVENTION ANALYSIS OF WATER USE RESTRICTION, AUSTIN, TEXAS,**
Texas Univ. at Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3D.
W88-05405

**AGGREGATE MARGINAL RETURNS FROM WESTERN IRRIGATED AGRICULTURE,**
Idaho Univ., Moscow. Dept. of Agricultural Economics.
R. B. Long.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1117-1124, December 1987. 2 fig, 4 tab, 11 ref.

Descriptors: *Marginal returns, *Economic aspects, *Irrigation, *Water allocation, *Water demand, *Economic efficiency, Pricing, Western United States, Water rights, Livestock, Crop yield, Crop production, Agriculture, Farms, Alternative water use, Water use, Productivity.

Pressure is increasing in the western United States to allocate water from irrigated agriculture to other competitive uses. Since water is normally allocated through water rights and not necessarily by the price system, the question of economic efficiency is a continual concern. Results show that returns per acre-foot of water used in western irrigation are quite high and are closely tied to the livestock industry. Returns per acre-foot of water used for crops ranged from $60 to $1,500. When water was used to support livestock, returns per acre-foot ranged from $100 to $600. Clearly, losses of water supply that reduced irrigation production could also lower farm income significantly. Estimated returns also show what alternative uses would have to pay for water under competitive market conditions. Production elasticities are also shown for various states. (Author's abstract)
W88-05415

**MODEL OF DAILY MUNICIPAL WATER USE FOR SHORT-TERM FORECASTING,**
Interstate Commission on the Potomac River Basin, Rockville, MD.
J. A. Smith.
Water Resources Research WRERAO, Vol. 24, No. 2, p 201-206, February 1988. 3 fig, 15 ref. Water Resources Research Program Grant 14-08-0001-G-1145.

Descriptors: *Water use, *Water demand, *Model studies, *Municipal water use, *Forecasting, Prediction, Reservoirs, Washington, Mathematical equations, Estimating.

A time series model of daily municipal water use, termed a conditional autoregressive process, can be interpreted as an autoregressive process with randomly varying mean. The randomly varying mean accounts for changes in water use that result from the complex interaction over time of 'structural features' of the water use system. These features may include the price of water, total service area connections, plumbing code provisions, and customer income. The modeling approach is semiparametric. The model can be split into a component that is treated in a nonparametric framework and a component that is treated parametrically. The random mean process, which represents long-term trends in water use, is treated in a nonparametric framework. Conditional on the random mean water use, the model reduces to a Gaussian autoregressive process with a modest number of parameters. The water use model is the core of a forecast system which is used to schedule releases from two water supply reservoirs which serve the Washington, D.C., Metropolitan Area. Model structure dictates that the key step in producing a water use forecast is an updating step in which a revised estimate of current mean water use is computed. (Author's abstract)
W88-05434

**WATER RESOURCES LAW.**
For primary bibliographic entry see Field 6E.
W88-05654

**WHY NOT CONSISTENCY IN WATER LAW,**
Morrison-Knudsen Engineers, Inc., Denver, CO.
For primary bibliographic entry see Field 6E.
W88-05655

**PROPERTY RIGHTS IN WATER: AN ESSENTIAL ELEMENT OF ECONOMIC AND SOCIAL DEVELOPMENT,**
McDonough, Holland and Allen, Sacramento, CA.
For primary bibliographic entry see Field 6E.
W88-05656

**PRIOR APPROPRIATION DOCTRINE UNDER STRESS: THE MONTANA CASE STUDY,**
For primary bibliographic entry see Field 6E.
W88-05658

**LEGAL CONSTRAINTS ON THE STATE OF KANSAS IN IMPOSING CONSERVATION PRACTICES ON HOLDERS OF EXISTING AGRICULTURAL WATER RIGHTS,**
Kansas Univ., Lawrence. School of Law.
For primary bibliographic entry see Field 6E.
W88-05659

**RIPARIAN RIGHTS TO STREAMFLOW AND THEIR APPLICATION IN EASTERN STATES,**
North Carolina State Univ., Raleigh. Dept. of Biological and Agricultural Engineering.
For primary bibliographic entry see Field 6E.
W88-05660

**COLORADO EXPERIENCE IN RESOLVING SURFACE-GROUND WATER CONFLICTS,**
Grant, Bernard and Lyons, Longmont, CO.
For primary bibliographic entry see Field 6E.
W88-05661

**IRRIGATION WATER ALLOCATION IN SOUTH DAKOTA,**
South Dakota State Univ., Brookings. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 6E.
W88-05663

**IMPACT OF CITY OF TEQUESTA VS JUPITER INLET CORPORATION ON FLORIDA ADMINISTRATIVE WATER LAW,**
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 6E.
W88-05665

**PROTECTING INSTREAM WATER USES IN THE RIPARIAN DOCTRINE STATES,**
Virginia Polytechnic Inst., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6E.
W88-05666

**ALLOCATING WATER TO INSTREAM USES: PRIVATE ALTERNATIVES,**
Lewis and Clark Coll., Portland, OR. Natural Resources Law Inst.
For primary bibliographic entry see Field 6E.
W88-05668

**INSTREAM FLOW LITIGATION: A SURVEY FOR MANAGERS,**
National Ecology Center, Fort Collins, CO.
For primary bibliographic entry see Field 6E.
W88-05669

**SURFACE WATER AND GROUNDWATER REGULATION AND USE: AN ETHICAL PERSPECTIVE,**
Southern Illinois Univ. at Carbondale. Dept. of Agribusiness Economics.
For primary bibliographic entry see Field 6E.
W88-05674

**HYDROLOGY AND WATER LAW-COOPERATION FOR THE FUTURE,**
Hardt (W.F.) and Associates, Orange, CA.
For primary bibliographic entry see Field 6E.
W88-05676

**WATER RIGHTS: SCARCE RESOURCE ALLOCATION, BUREAUCRACY, AND THE ENVIRONMENT.**
For primary bibliographic entry see Field 6E.
W88-05679

**APPROPRIATORS VERSUS EXPROPRIATORS: THE POLITICAL ECONOMY OF WATER IN THE WEST,**
University of West Florida, Pensacola. Dept. of Political Science.
For primary bibliographic entry see Field 6E.
W88-05680

**INSTITUTIONAL RESTRICTIONS ON THE TRANSFER OF WATER RIGHTS AND THE SURVIVAL OF AN AGENCY,**
New Mexico Univ., Albuquerque. Dept. of Economics.
For primary bibliographic entry see Field 6E.
W88-05684

**ECONOMIC DETERMINANTS AND CONSEQUENCES OF PRIVATE AND PUBLIC OWNERSHIP OF LOCAL IRRIGATION FACILITIES,**
Chicago Univ., IL. Dept. of Economics.
For primary bibliographic entry see Field 6E.
W88-05685

**PRIVATIZING GROUNDWATER BASINS: A MODEL AND ITS APPLICATION,**
Montana State Univ., Bozeman. Dept. of Economics.
For primary bibliographic entry see Field 6E.
W88-05686

**INSTREAM WATER USE: PUBLIC AND PRIVATE ALTERNATIVES,**
Lewis and Clark Coll., Portland, OR. Natural Resources Law Inst.
For primary bibliographic entry see Field 6E.
W88-05687

**AMERICA'S WATER: CURRENT TRENDS AND EMERGING ISSUES.**
Conservation Foundation, Washington, DC.
The Conservation Foundation, Washington, DC. 1984. 114 p.

Descriptors: *Water management, *Water supply, *Water quality, *Management planning, *Water resources development, Groundwater management, Costs, Economic aspects, Conflicting use, Water demand.

An up-to-date assessment of trends in water quantity and quality in the United States is provided. Many parts of the nation are facing substantial problems in water supply. Over 2,000 gallons of water/person/day are now being withdrawn from U.S. surface water and groundwater, and over 450 gallons of that are being consumed. The quality of U.S. water has changed little since 1972. Almost no effort has been made to control runoff from agricultural and other lands, and many municipal wastewater-treatment plants are either not completed or not operated properly. This Issue Report explores how the United States is moving from an era of water development to one of water management to deal with these problems. This shift requires careful attention to allocating and paying for water efficiently, equitably, and with proper concern for environmental quality. Conflict over these concerns has already emerged and is growing. State and local governments need to nurture, rather than ignore, innovative efforts to resolve these conflicts before they become crises. The federal government should encourage such efforts, but it cannot mandate them. (Lantz-PTT)
W88-05913

**RIVERS OF EMPIRE: WATER, ARIDITY, AND THE GROWTH OF THE AMERICAN WEST,**
Brandeis Univ., Waltham, MA. American Environmental Studies.
D. Worster.
Pantheon Books, New York. 1985. 402 p.

Descriptors: *Water supply, *Water demand, *Arid regions, *Water resources development, Ecological effects, Economic aspects, Reservoirs, Dams, Canals, Pesticides, Agriculture, Industry, History.

From the turn of the century, when Southern Pacific Railroad barons were given one-tenth of the land in California to develop, to the Depression, when wealthy growers of the Imperial and Central valleys monopolized the region's cheap, publicly subsidized water supply, right up to today, when Arizona cotton farmers are locked in a tug-of-war with sunbelt cities for the dwindling water supplies, aridity and the control of water have totally determined the face of the West. In a reinterpretation of the region's history, it is shown that the West can be seen most clearly as a modern hydraulic society, based upon, shaped by, and completely dependent upon its dams, reservoirs, and canals. The results are the growth of the American Western empire, social and economic stratification, gross exploitation of migrant workers, lethal pollution from pesticides and chemical fertilizers, and total dependence on the technocrats who manage the precious hydraulic system (a system that is even now breaking down). (Lantz-PTT)
W88-05916

## 6E. Water Law and Institutions

**CONFLICT RESOLUTION IN WATER RESOURCES: TWO 404 GENERAL PERMITS,**
Institute for Water Resources (Army), Fort Belvoir, VA.
J. D. Priscoli.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 114, No. 1, p 66-77, January 1988. 16 ref.

Descriptors: *Permits, *Legal aspects, *Water resources development, *Negotiations, Corps of Engineers, Wetlands, Louisiana, Mississippi, Florida.

The use of alternative dispute resolution techniques in water resources is demonstrated and experience evaluated against current theory of bargaining and negotiating. Conflicts among environmentalists, developers, and government agencies are well known; they involve planning, constructing, operating, and regulating water resources projects. Two Section 404 permit cases are compared. One in 1980, involves issuing a general permit (GP) for wetland fill on Sanibel Island, Florida. The other, in 1987, involves issuing a GP for hydrocarbon exploration drilling throughout Louisiana and Mississippi. Generally, permits are granted on a case-by-case basis, but Corps district engineers may also issue GPs for activities that produce no negative cumulative impacts. In these cases the Corps adopted a revolutionary approach to GPs. Rather than writing the permit in house, the Corps suggested that the parties who conflict over permit applications get together and write the technical specifications for a GP. The Corps told environmentalists, citizens, contractors, industrialists, developers, and representatives of government agencies if they agree to the specifications of a permit within the broad legal constraints of the 404 law, the Corps would confirm the agreement and call it a GP. The price of such an agreement is consensus among the parties normally in conflict over permit applications. In this way the Corps becomes the facilitator of consensus among interested parties by using its authority. The Sanibel permit operated unchallenged for five years, the legal life of such a permit. The Mississippi/Louisiana permit was just issued. These cases both confirm and question some propositions emanating from the fields of negotiating and bargaining. (Author's abstract)
W88-05153

**WATER AND DEVELOPMENT: A COMPLEX RELATIONSHIP,**
Virginia Polytechnic Inst. and State Univ., Blacks-

burg. Dept. of Civil Engineering.
W. E. Cox.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 114, No. 1, p 91-98, January 1988. 21 ref.

Descriptors: *Water resources development, *Economic growth, *Socioeconomic aspects, *Available water, Economic aspects, Water resources, Development.

The water resource has a wide range of interactions in socio-economic development processes. Water projects that enhance the attributes of water, or control its negative effects, may stimulate development and have been used as development tools. However, studies of the impact of water availability and investment in water projects on development have produced mixed results, with some studies focusing on the United States detecting no positive correlation between water and patterns of socio-economic development, level of water availability, and prevailing mix of economic activities. Water must be viewed as one of several elements of the growth process with potential to become a limiting factor. Thus, water development cannot be used indiscriminately as a mechanism to stimulate socio-economic advancement, but appropriate attention must be given as part of a broad assessment of the many interacting factors important to socio-economic advancement. (Author's abstract)
W88-05155

**APPROACHING POLLUTION CONTROL VIA THE WALLET,**
For primary bibliographic entry see Field 5G.
W88-05428

**KEY ISSUES OF THE DRINKING WATER AMENDMENTS,**
K. J. Miller.
WATER/Engineering and Management WENMD2, Vol. 135, No. 2, p 30-32, February 1988.

Descriptors: *Water quality control, *Water quality standards, *Drinking water, *Safe Drinking Water Act, *Regulations, *Management planning, Lead, Disinfection, Water treatment, Organic compounds, Monitoring.

The EPA is now well into the process of establishing what will be the most comprehensive, complex set of regulations and guidelines in the history of the water supply industry from the Safe Drinking Water Act Amendments of 1986 (SDWA). Five areas of utilities efforts will have significant influence on operation, overall cost, and public perception in the near future: lead, surface water treatment, radionuclides, disinfection and disinfection byproducts, and volatile and synthetic organic chemicals (VOCs and SOCs). The impact of regulations in each of these areas as well as regulatory timetables are discussed. The water supply community can contribute to the establishment of the new SDWA regulations in the following ways: take part in the regulatory process; establish close ties with the state primacy agency; and monitor for contaminants. (VerNooy-PTT)
W88-05430

**DEVELOPMENT OF THE RIO DE LA PLATA SYSTEM,**
A. Danilevsky.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 6, p 761-778, November 1987. 8 fig, 1 tab, 64 ref.

Descriptors: *Rio de La Plata, *Watersheds, *Water resources development, *Climatology, *Water use, *Water management, *International waters, Navigation, Hydroelectric power, Flood control, Political aspects, Economic aspects, Social aspects, Planning.

A brief description of the Rio de La Plata hydrographic basin, the second largest in South America and the fifth largest in the world, is given. Its location, extension, and climate are mentioned. The catchments are identified and the course of the rivers described. Brazil's and Argentina's energy needs, as well as present and planned hydroelectric developments in the basin, are commented upon. It is shown how much nature favored Brazil over Argentina by giving her the upper course of the rivers. Improvements for navigation on the Rio Parana and the Rio Uruguay are discussed, as are the difficulties of the flood control problem on the Middle and Lower Parana. Some other related projects are described. Finally, the conflicting interests of the various nations who share the Rio de La Plata basin are analyzed, stressing the necessity of managing international rivers as a system. (Author's abstract)
W88-05613

**CONSIDERATION OF GALLOWAY PROJECT,**
Nevada Univ., Reno. Dept. of Civil Engineering.
J. W. Bird.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 5, p 616-619, September, 1987. 10 ref.

Descriptors: *Galloway Project, *Colorado River, *Interbasin transfer, *Colorado River Compact, *Legal aspects, *Water rights, *Interstate compacts, Riparian rights, Political constraints, Water law, Legislation, Economic aspects.

The Galloway Project has presented the states on the Colorado River with a proposal requiring a new definition of rights under the Colorado River Compact. These proposals have caused several agencies and states to reevaluate the Colorado River Compact, and to reconsider their present position on the meaning of the terms that have been defined. The Galloway Project proposal is causing a new consideration of water leasing, states rights, state politics, and interstate sales of water. These issues are discussed. It is concluded that, whether or not Galloway is successful, the issue of interstate sale of water rights to out-of-basin users will return. Some of the legal obstacles appear to be illusory, but are in fact subject to judicial interpretation. Questions relating to the amount of water actually available for appropriations are not significant next to political questions. The future will probably see more projects proposed similar to the Galloway Project. (Author's abstract)
W88-05637

**WATER RESOURCES LAW.**
Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. American Society of Agricultural Engineers, St. Joseph, Michigan, 1986. 243 p.

Descriptors: *Water law, *Groundwater management, *Water quality control, *Riparian rights, *Water rights, United States, Legal aspects, Diversion, Water consumption, Water management, Consumptive use, Nonpoint pollution sources, Water allocation, Irrigation permits, Water zoning, Political aspects.

In this first National symposium on water resources law sponsored by the American Society of Agricultural Engineers, lawyers, consultants, administrators, researchers, economists, and engineers came together to address some of the issues related to water supply and water quality. Topics discussed include: selected issues on water law in 1986; prior appropriation issues, groundwater issues, instream flow issues, water quality issues, and emerging issues for the future. Some of the long-held methods of appropriating water rights such as the Prior Appropriation Doctrine in the western United States and the Riparian Rights Doctrine in the eastern United States have come under increasing scrutiny. Maintenance of minimum water flow in streams to maintain aquatic life has resulted in conflicts among conservationists, fish and wildlife interests and potential water users. The conflicts that have occurred among the many competing users have resulted in the enactment of considerable legislation at all levels of government. The combined efforts of the legal community, education, adequate levels of financial resources and all levels of government are required to find practical solutions that will provide safe, adequate supplies of water to meet the needs of this nation now and for future generations. (See W88-05655 thru W88-05678) (Geiger-PTT)
W88-05654

**WHY NOT CONSISTENCY IN WATER LAW,**
Morrison-Knudsen Engineers, Inc., Denver, CO.
R. E. Waddington.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 20-27, 1 tab, 9 ref.

Descriptors: *Water law, *Water allocation, *Riparian rights, *Western United States, *Water rights, *Prior Appropriations Doctrine, Legal aspects, Water use, Consumptive use, Nonconsumptive use, Water management.

Water law in nearly all states west of the Mississippi River is based on the prior appropriations doctrine. However, the administration of these rights differs greatly among these western states. The degree of regulation and the procedures for implementing them are the areas which vary greatly from state to state. One imperfection in the system of prior appropriations is that it encourages overirrigation and waste because the allotment is lost unless put to beneficial use. In times of shortage, the junior appropriator is made to bear the entire loss rather than prorating the available water among users. Some states have suspended priorities during periods of low flow and allocated the supply among preferred users. Some reasons for modifying the existing prior appropriations doctrine and for not changing it are discussed. Such factors as due diligence, cancellation proceedings, and adjudication procedures could be uniform among states. However, the current economic conditions, legal stratification, and provincialism associated with water rights tend to discourage any trend toward uniformity in administration in the Western United States. (See also W88-05654) (Geiger-PTT)
W88-05655

**PROPERTY RIGHTS IN WATER: AN ESSENTIAL ELEMENT OF ECONOMIC AND SOCIAL DEVELOPMENT,**
McDonough, Holland and Allen, Sacramento, CA.
S. L. Somach.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 28-34.

Descriptors: *Water law, *Water rights, *Riparian rights, *Economic aspects, *Water allocation, Legal aspects, Social aspects, Water management, Water use, Water quality.

The emerging concepts dealing with the instream use of water ignore the pre-existing system of water rights which was developed to accommodate and foster certain types of social and economic development. Statutory and regulatory zeal for the imposition of water quality controls has resulted in legislation and regulation that ignores the fundamental limitations imposed upon government action by property-right-based water allocation systems. Regulatory and judicial action that attempts to provide protection for instream and associated uses of water has also ignored the fundamental limitations imposed upon government action by property right based water allocation systems. The appropriative right system facilitated the economic and social development of the arid and semi-arid regions of the Western United States. Application of the Public Trust Doctrine in an appropriative water right system could be catastrophic. The injection of the public trust doctrine, independent of the property based system in water rights, adds the element of uncertainty that the appropriative water right was designed to avoid. The application of reasonable instream protections need not be destabilizing to the property based system of water rights if a system of prioritization of instream uses is applied. (See also W88-05654) (Geiger-PTT)
W88-05656

**WATER DUTY: BASIS FOR WATER ALLOCATION,**
Arizona Univ., Tucson. Dept. of Agricultural Engineering.
M. Yitayew, and W. E. Hart.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 35-49, 5 tab, 12 ref.

Descriptors: *Water law, *Water rights, *Water allocation, *Water management, *Water costs, Legal aspects, Economic aspects, Irrigation efficiency, Water demand, Precipitation, Leaching, Models, Water conservation, Evapotranspiration.

Significant levels of water conservation can be achieved through the use of carefully defined water duties. The objectives of allocation, the scientific evidence available, and farmer, state agencies and federal agencies notions of fairness determine the probable success in using water duty for water allocation purposes. Careful evaluation of scientific information on crop evapotranspiration, leaching, efficiency and effective precipitation, and the factors affecting these elements, are the bases for an accurate establishment of water duty. Accuracy in establishing relationships between water duty and these elements can be achieved by using appropriate models and data sets available for a given area. Case studies of the use of water duties in Arizona and California are given. Decisions on the basis of allocation, such as crop versus irrigated acreage or a combination of both, seasonal or yearly, uniform or varied, must be carefully made based on each alternative's merit. The choice should be made on the condition of each area so that economy of use and equity for the farmers and the general public is fostered. (See also W88-05654) (Author's abstract)
W88-05657

**PRIOR APPROPRIATION DOCTRINE UNDER STRESS: THE MONTANA CASE STUDY,**
J. E. Thorson, and S. A. Bond.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 50-58, 8 ref.

Descriptors: *Water allocation, *Water law, *Prior Appropiation Doctrine, *Water rights, *Montana, *Water transfer, Interbasin transfers, Water transport, Legal aspects, Economic aspects, Water use, Water demand, Water management, Water policy, Riparian rights, Water costs.

Throughout the West, the prior appropriation doctrine and the water rights obtained under this doctrine are under stress. Pressures on the doctrine have come from decisions of the U.S. Supreme Court and other fedral courts that have recognized water as a commodity to be marketed and have lessened the ability of states to prevent interstate transfer of the resource. These regional trends are examined in Montana. In this Western state, public controversy over water exports and water sales, litigation over stream access and the public trust doctrine, litigation in nearby states over the Missouri River, and set-backs for the state's general stream adjudication process have occurred. In response to these problems, Montana has made increased efforts to quantify existing uses of water, to ascertain and safeguard future needs, to develop an interstate water strategy, and to incorporate public interest concerns into the fabric of water state management. (See also W88-05654) (Geiger-PTT)
W88-05658

**LEGAL CONSTRAINTS ON THE STATE OF KANSAS IN IMPOSING CONSERVATION PRACTICES ON HOLDERS OF EXISTING AGRICULTURAL WATER RIGHTS,**
Kansas Univ., Lawrence. School of Law.
J. C. Peck, and M. K. Ramsey.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 59-66.

Descriptors: *Water law, *Water rights, *Water conservation, *Kansas, *Irrigation efficiency, *Management planning, Legal aspects, Crop production, Water use efficiency, Groundwater depletion, Water allocation, Irrigation practices, Public policy, Water policy, Water permits.

In 1981, the Kansas state legislature added conservation and management of water as basic reasons for establishing a state water plan. The water plan proposes that any holder of a water right could be required to prepare a conservation plan when the chief engineer deems it to be in the public interest. The chief engineer also is given authority to require applicants for permits to adopt and implement conservation plans and practices. Once the water right is granted, it becomes a property right. The legal issue that arises in the conservation area has to do with those water rights that already exist in the state of Kansas (appproximately 38,000 in number). The question is posed as to whether the state of Kansas can impose conservation requirements on holders of water rights without infringing on constitutionally protected property rights. A brief analysis of the law of Kansas and other states concerning this legal issue is presented. The questions concerning the nature of water rights, the history of the development of Kansas water law, the constitutional issue of taking of property versus regulation of property, the status of the law on takings versus regulation in Kansas and elsewhere, and public trust doctrine are addressed. A spectrum of possible state actions are discussed which range from the extreme of doing nothing to the opposite extreme of leaving to future generations the same amount of water available at present. (See also W88-05654) (Geiger-PTT)
W88-05659

**RIPARIAN RIGHTS TO STREAMFLOW AND THEIR APPLICATION IN EASTERN STATES,**
North Carolina State Univ., Raleigh. Dept. of Biological and Agricultural Engineering.
D. W. Miller, M. S. Heath, and R. E. Sneed.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 67-74, 6 ref.

Descriptors: *Riparian rights, *Reasonable use, *Water law, *Streamflow, *Eastern United States, *Eminent domain, Legal aspects, Water management, Water use, Water demand, Water allocation, Water rights, Irrigation efficiency, Public policy, Water policy.

Several areas of the riparian doctrine as it is applied in the Eastern United States are in need of reform. The recognition of public use rights is an example of an area where reform is needed. The mechanism of eminent domain must be balanced by instruments that would preserve important instream uses against the prospect of indiscriminate reductions in flow. A second reform would be to broaden the meaning of reasonable use so that it would explicitly incorporate the view of priority expressed in the Second Restatement of Torts. Under this section the protection of existing values of water uses and land investments should be considered in determining the reasonableness of a new use. A third change would be reform of the restrictions on the place of use imposed by the common law of riparian rights. Case reviews show consensus that some application of appurtenancy standards, and of the watershed limitation results in subjecting many otherwise reasonable, beneficial, and useful diversions to unwarranted liability. Management of irrigation and drainage waters raises some challenging questions which may foster further modifications of the law. A unified approach to water management may appear desirable leading some jurisdictions to adopt conjunctive ground and surface water rights. Reform of the surface water laws of eastern states may follow two paths. The first would lead state legislatures to enact provisions fundamentally altering water rights. A second course would see reforms emerge as courts modify existing common law principles to meet changing conditions. The evolution of the riparian doctrine through judicial decisions may guide eastern states to practical solutions for managing surface waters. (See also W88-05654) (Geiger-PTT)
W88-05660

**COLORADO EXPERIENCE IN RESOLVING SURFACE-GROUND WATER CONFLICTS,**
Grant, Bernard and Lyons, Longmont, CO.
J. J. Khan, and R. A. Longenbaugh.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 76-83, 16 ref.

Descriptors: *Water law, *Water rights, *Riparian rights, *Legal aspects, *Colorado, *Groundwater management, *Public participation, Water mangement, Surface water, Water resources development, State jurisdiction, Water allocation, Water policy, Public policy.

The Colorado experience in addressing the conflict between those seeking to develop the groundwater resource and those users dependent on the continued supply from surface streams has shown that there are definite advantages to the adoption of region-wide jurisdiction. The rules Denver Basin have expedited the consideration of applications for well permits by the State Engineer. There is greater certainty as to the result of the permitting process with the result that attorneys and engineering consultants can advise their clients accordingly. The adoption of the rules should also reduce the amount of litigation. Several recommendations are summarized for those involved in any large-scale rule, regulation, or policy-making process governing resource use on a region-wide basis. As much data as possible should be collected. Methods of analysis, modeling and display of results should be selected carefully. All decisions and final products should be reviewed, approved, and endorsed by outside experts, if possible. As much participation as possible by interested parties in the promulgation process should be allowed, both before and during the formal adoption process. A knowledgeable hearing officer should be selected and allowed to participate in the hearing process. If testimony must be limited to meet deadlines, the direct and rebuttal oral testimony should be limited. All parties should be flexible, both before the adoption of the rules, regulations or policies and after their adoption. Time deadlines should be set for completion. The affected parties should limit their attack to areas where they have superior data or analytical tools available. They should always present an alternative rule, regulation or policy in addition to attacking the proposed one. Data or alternative methods of analysis should be presented in a timely fashion, as early as possible. For purposes of judicial appeal and review after adoption, legal defects in the promulgated rules, regulations or policies should be analyzed. (See also W88-05654) (Geiger-PTT)
W88-05661

**LEGAL RECOGNITION OF RIGHTS TO GROUND WATER STORED INCIDENTLY BENEATH A SURFACE IRRIGATION PROJECT - NEBRASKA'S LEGAL EXPERIMENT,**
Crosby, Guenzel, Davis, Kessner and Kuester, Lincoln, NE.
L. W. Orton.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 84-93, 1 fig.

Descriptors: *Water law, *Water rights, *Groundwater storage, *Nebraska, *Surface water, *Legislation, Legal aspects, Water management, Irrigation programs, Water use, Riparian rights, Water allocation, Groundwater mining, Water policy.

General water appropriation laws in Nebraska traditionally applied to surface water use and storage rights were extended to recovery and beneficial use of groundwater. With the passage of LB 198 (the Act) in 1983, the state may grant a permit recognizing incidental groundwater storage to anyone having an approved perfected surface water appropriation. That permit is subject to the following conditions: the rate, quantity or time of original diversion may not increase; additional irrigated lands may be approved for service if in the public interest and if senior appropriations are not materially interfered with; the priority data of the

original appropriation must apply; and, the storage is being withdrawn or otherwise beneficially being used. Several issues arising from the Act are as follows: whether the recognition of water stored underground as an independent classification of water, the quantification of that storage, and the modification of surface water appropriations to include its beneficial use for underground water storage are legitimate actions of the State not in contravention of the rights of overlying landowners; whether such a modification if valid may be applied retroactively to waters stored underground prior to enactment of the law; and, what technical proofs are required to identify water stored underground, its source of supply and quantity. The issues involved in incidental storage and recovery are significantly less complex than those involved with intentional groundwater storage. As a result, the rules governing intentionally stored supplies may warrant further testing in the Nebraska legislature. (See also W88-05654) (Geiger-PTT)
W88-05662

**IRRIGATION WATER ALLOCATION IN SOUTH DAKOTA,**
South Dakota State Univ., Brookings. Dept. of Agricultural Engineering.
C. H. Ullery, H. D. Werner, and L. W. Cluever.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 94-103, 2 fig, 2 tab, 14 ref.

Descriptors: *Water allocation, *Water rights, *Water law, *Irrigation permits, *South Dakota, *History, Irrigation water, Legal aspects, Irrigation practices, Water permits, Irrigable land, Water policy, Soil water potential, Riparian rights.

The history of irrigation in South Dakota and the two permit programs which regulate irrigation development in that state are reviewed. Irrigation was introduced into South Dakota by pioneers who settled along streams originating in the Black Hills. During the early 1900's private development continued along the streams in the western half of the state. Generally poor economic conditions in agriculture and severe drought during the 1920's and 1930's reduced the irrigated area of South Dakota. After World War II irrigated agriculture began appearing in eastern South Dakota and continued to steadily increase. During the 1960's and 1970's the expansion of irrigated land continued in South Dakota. Since 1979, the area of irrigated land has stabilized at about 202 thousand hectares. South Dakota requires two permits prior to developing irrigated land. A soil-water compatibility permit, issued by the South Dakota Department of Agriculture, assures that the land and water are suited to maintain the long-term production capability of the land. In addition a water right, issued by the South Dakota Department of Water and Natural Resources, must be obtained to assure that over-appropriation of water resources does not occur. (See also W88-05654) (Geiger-PTT)
W88-05663

**ZONING TO PROTECT GROUNDWATER QUALITY,**
Wisconsin Univ.-Madison. Dept. of Agricultural Economics.
D. A. Yanggen.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 104-113, 17 ref.

Descriptors: *Water zoning, *Water quality, *Water law, *Land use, *Wisconsin, Riparian rights, Legal aspects, Water rights, State jurisdiction, Groundwater pollution, Water management, Water pollution prevention.

The power of local government to regulate land use is an important part of a state or local regulatory system to prevent groundwater contamination. The basic concepts of groundwater management, legal principles, zoning practices and possible local regulatory strategies used to prevent pollution in the state of Wisconsin are examined. Protection techniques available to implement groundwater quality include groundwater quality standards, source-oriented controls, land use controls, state and local regulatoy powers and cleanup requirements. The local groundwater planning and regulatory process is shaped by some basic considerations. Substances vary considerably in their potential to contaminate groundwater. Some land areas are more susceptible to contamination than others. Pollution potential can be reduced through construction standards and best management practices in some cases. The population at risk from exposure to pollutants may vary. Intergovernmental cooperation is needed for effective management. Some selected cases dealing with groundwater regulations are presented that illustrate the relationship between the legal principles, mangement concepts and regulatory strategies previously discussed. Local land use controls which delineate special areas susceptible to contamination, prohibit uses which might cause contamination, allow other uses only as conditional uses, and set lower densities, can be an important part of a groundwater management effort. It is important to relate the stringency of the regulations to the degree of threat to the public harm in order to comply with constitutional protections of private property. This can be accomplished by carefully documenting the relationship between the regulations and public health and through the use of flexible zoning devices such as various groundwater protection overlay zoning districts with appropriate restrictions. (See also W88-05654) (Geiger-PTT)
W88-05664

**IMPACT OF CITY OF TEQUESTA VS JUPITER INLET CORPORATION ON FLORIDA ADMINISTRATIVE WATER LAW,**
Florida Univ., Gainesville. Dept. of Agricultural Engineering.
L. B. Baldwin, and R. R. Carriker.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 114-121, 6 ref.

Descriptors: *Water law, *Florida, *Water rights, *Riparian rights, *Well permits, *Florida, State jurisdiction, Aquifers, Saline water intrusion, Land use, Water resources development, Legal aspects, Case studies, Water permits, Property rights, Groundwater mining, Legislation, Water allocation.

In 1972, the Florida Legislature passed a comprehensive water resources act declaring all waters of the state subject to regulation and establishing an administrative structure to carry out the regulation. That act was tested in the courts when the City of Tequesta's well field, in a limited yield aquifer, was protected through denial of a well permit for a nearby development. The developer challenged the denial as a taking of a property right, and the case went through the court system to the Florida Supreme Court (The Village of Tequesta v. Jupiter Inlet Corporation). The successful brief filed in this landmark case represented a history of evolving water law and argued the separation of rights to water from the rights of land owvership. The Supreme Court found in favor of the state's right to control and allocate water resources irrespective of location relative to land ownership, thus enabling continued administration of consumptive water use permitting in Florida. (See also W88-05654) (Author's abstract)
W88-05665

**PROTECTING INSTREAM WATER USES IN THE RIPARIAN DOCTRINE STATES,**
Virginia Polytechnic Inst., Blacksburg. Dept. of Civil Engineering.
W. E. Cox.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 124-130.

Descriptors: *Water law, *Riparian rights, *Water rights, *Water use, *Instream flow, *Eastern United States, Streamflow, Legal aspects, Water management, Institutional constraints, Water policy, Minimum flow, Decision making.

Protection of instream water-use activities is becoming increasingly important in water management in the riparian doctrine states. Increased interest in environmental protection and water-related recreation has raised concern that water management institutions may not be achieving a proper balance between use of water in its many offstream applications and uses that depend on the maintenance of minimum flows and water levels in natural waters. Institutional mechanisms for protecting minimum flows generally fall into two categories: measures incorporated into state water law that integrate instream water uses into the process for allocating water among competing water uses, and direct regulatory measures that supplement water allocation law by restricting water development activities. These two classes of institutional mechanisms are reviewed as they currently exist within the eastern United States where the riparian doctrine allocates water among uses. The current level of legal protection afforded instream uses is outlined. The assessment suggests that, while the existing institutional framework within the riaprian states provides a degree of protection for instream water use, systematic consideration of instream water uses within water-use decision processes is not assured. Approaches to improving protection of instream water use involving more effective utilization of existing institutions and modification of applicable institutions are considered. (See also W88-05654) (Geiger-PTT)
W88-05666

**PROTECTING FRESHWATER INFLOWS INTO TEXAS ESTUARIES: AN EVALUATION OF LEGAL STRATEGIES,**
Texas A and M Univ., College Station. Inst. of Renewable Natural Resources.
R. A. Kaiser, and S. M. Kelly.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 131-139, 11 ref.

Descriptors: *Water law, *Water rights, *Minimum flow, *Estuaries, *Texas, *Legal aspects, Riparian rights, Selective withdrawal, Water zoning, Diversion, Water policy, Water permits, Water use, Water allocation, Water conservation, Public policy, Instream flow.

Although freshwater inflow into bays and estuaries remains a low priority use of water in Texas, there are a number of approaches to estuarine and minimum flow protection that could be pursued under current law. The strategies evaluated include: direct acquisition of water rights through appropriations, contractual agreements, or condemnation of existing water rights; administrative approaches such as reservation, conditional permits, redefined water use priorities, water conservation, and zoning; and application of the public trust doctrine. Several changes are suggested to create a coordinated legal structure for protecting freshwater inflows into estuaries. These include: cancelling existing permits that do not conform to the statutory definition of beneficial use; reserving from appropriation the amounts of water needed to ensure minimum monthly inflows of freshwater to each estuary system; zoning and selective permit issuance; increasing water supplies through groundwater withdrawal management and import of water from other states. Since the attitude of Texas courts is currently unclear in cases involving the public trust doctrine, such litiation might best be postponed until other options have been attempted or until the courts give some indication of favoring the public trust approach. (See also W88-05654) (Geiger-PTT)
W88-05667

**ALLOCATING WATER TO INSTREAM USES: PRIVATE ALTERNATIVES,**
Lewis and Clark Coll., Portland, OR. Natural Resources Law Inst.
J. L. Huffman.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 140-147, 40 ref.

Descriptors: *Water allocation, *Water rights, *Water law, *Minimum flow, *Water demand, *Appropriation doctrine, Instream flow, Water use efficiency, Economic aspects, Consumptive use, Legal aspects, Water policy, Riparian rights, Water management.

The almost exclusive response to the growing demand for streamflow maintenance has been some form of governmental action. Many proponents of state provision of instream uses contend that most instream uses will not be provided privately because of common-pool problems. Given the current and historic nature of the law, it is impossible for private parties to supply water for instream uses. The important issue remains not whether it is possible to privately allocate water to instream uses, but whether it is desirable. The answer to this question rests in the ongoing debate about privatization versus regulation and public management. Four characteristics of appropriation doctrine separately or in combination make private appropriation for instream use difficult or impossible: the diversion requirement, laws of abandonment and non-use, definitions of beneficial use, and limited rights of transfers. There is little reason to oppose the legal facilitation of private allocation of water to instream uses; every additional water supply in the stream, whether publicly or privately provided, will serve the objective of streamflow maintenance. (See also W88-05654) (Geiger-PTT)
W88-05668

**INSTREAM FLOW LITIGATION: A SURVEY FOR MANAGERS,**
National Ecology Center, Fort Collins, CO.
B. L. Lamb.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 148-157, 14 ref.

Descriptors: *Water law, *Water rights, *Water appropriation, *Minimum Flow, *Instream flow, Water permits, Evidence, Water management, Legal aspects, Case studies, Beneficial use, Political aspects, Water permits.

Cases involving conflicts over instream uses of water are seldom brought to trial. The cases that have been tried fall into four categories: federal reserved rights, federal permits and licenses, state regulations, and water rights. These cases demonstrate that instream uses of water can be protected, and that, under certain circumstances, state and federal agencies can either regulate the use of property to protect instream flows or can hold a usufructory right to flowing water. Relevant lessons that can be learned by natural resource managers from these cases are outlined. Managers should seek to teach the lawyers who serve them so that the attorney's intimate knowledge of legal procedures can be applied cooperatively with the scientists to develop strategies for presentation of evidence, argument, and cross examination. Lessons for instream flow managers from federal reserved rights cases suggest that managers should plan studies with an eye toward fitting them into the overall process of the litigation with careful attention both to the requirements of evidence and science. In cases involving federal permits or licenses, litigation may continue for many years so that the manager who is a careful planner and record-keeper is desirable. In cases involving state water rights, statutory programs are often tested for constitutionality. In general, managers and their counsel should plan cases together in four steps: outline the case, design a technical work program, mutually critique the theory of the case and technical studies, and then plan to strengthen the case. (See also W88-05654) (Geiger-PTT)
W88-05669

**CHANGING AGRICULTURAL PROPERTY RIGHTS IN THE ENVIRONMENTAL ERA,**
Purdue Univ., Lafayette, IN. Dept. of Agricultural Economics.
S. B. Lovejoy, and H. R. Potter.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 160-169, 1 tab, 21 ref.

Descriptors: *Water pollution prevention, *Water law, *Water rights, *Property rights, *Water quality control, *Entitlement rules, Social aspects, Political aspects, Legal aspects, Nonpoint pollution sources, Compensation, Agricultural runoff, Environmental protection, Public participation.

Changes in water law and property rights that affect agriculture as well as some of the social forces leading to these changes are examined. Attention to soil and water conservation and environmental protection have lessened the freedom of farmers to choose cropping patterns and production practices. New legislation to control erosion and pollution problems associated with agriculture have helped change the definition of property rights. Some potential effects or impacts of changing the present system of property rights or entitlement structure (Rule III) to an alternative structure (Rules I, II, IV or V) are discussed. In a move to Rule I, as an extension of the Federal Water Pollution Control Act to nonpoint pollution sources, farmers would not be permitted to discharge any pollutants without the public's consent. In a move to Rule II, society's rights to clean water would be paramount in the form of a liability rule. Farmers who discharged pollutants into society's waters would be liable for the damages caused by those pollutants. In a move to Rule IV, society would have the right to force the farmer to stop polluting, but would be required to compensate the farmer for damages. In a move to Rule V, society would have the right to force the farmer to stop polluting without any compensation to the farmer. Entitlement rules are established in the politcal arena with input from many segments of society. The best entitlement rule may vary with the resource in question, the source of pollution, as well as the myriad of cost and benefits associated with each rule and each shift in entitlement. (See also W88-05654) (Geiger-PTT)
W88-05670

**REGULATIONS FOR PROTECTING GROUNDWATER AGAINST AGRICULTURAL POLLUTANTS,**
Wisconsin Univ., Madison. Law School.
D. T. Massey.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 170-178, 7 ref.

Descriptors: *Water pollution prevention, *Agricultural runoff, *Wisconsin, *Groundwater management, *Water law, *Water pollution sources, Water pollution control, Farm wastes, Water quality management, Leaching, Fertilizers, Pesticides, Groundwater pollution, Water quality control.

Protection of groundwater through the enforcement of private remedies, such as negligence, strict liability, trespass and nuisance, to abate groundwater pollution has generally been inadequate. A variety of federal and state laws can be used to prevent groundwater pollution. Potential sources of agricultural pollution include animal feedlots, livestock wastes, fertilizers, pesticides and irrigation. These sources may be classified according to their place of origin relative to land surface and whether the pollution is caused by waste or non-waste related activities. Potential for groundwater pollution depends upon the source of pollution and the aquifer. The federal government became involved in efforts to protect groundwater with the passage of the 1972 amendments to the Federal Water Pollution Control Act. Even though several other acts relating to groundwater were adopted by Congress in the 1970's, only the Federal Insecticide, Fungicide, and Rodenticide Act relates directly to agricultural pollutants. States are beginning to develop their own strategies for solving groundwater problems. Wisconsin adopted legislation in 1983 requiring the Department of Agriculture, Trade and Consumer Protection (DATCP) to promulgate rules relating to fertilizer and pesticide storage, in addition to its existing rule relating to pesticide use and control. That legislation also required thte Department of Natural Resources (DNR) and other state regulatory agencies to adopt rules establishing groundwater standards for all facilities, practices and activities that could affect groundwater quality. Those rules establish enforcement standards and preventive action limits and measures to be taken if either are exceeded. Wisconsin also has established funds to ensure repair of facilities associated with groundwater management and cost-share programs to assist farmers in the construction of animal waste facilities. (See also W88-05654) (Author's abstract)
W88-05671

**LITTLE WATERS: THE RELATIONSHIP BETWEEN NON-POINT SOURCE WATER POLLUTION, SOIL EROSION AND AGRICULTURAL DRAINAGE,**
South Dakota Univ., Vermillion. School of Law.
J. H. Davidson.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 179-187.

Descriptors: *Nonpoint pollution sources, *Water pollution sources, *Agricultural runoff, *Water pollution prevention, *Water law, *Clean Water Act, Water pollution control, Pesticides, Fertilizers, Soil erosion, Farm wastes, Drainage, Permits, Drainage districts, Water permits.

Agricultural drainage systems are a significant source of pollution of the nation's waterways. Agricultural drainage systems can be categorized as surface drainage, which includes open channels or subsurface systems. Drainage water or irrigation return flows carry sediment and chemicals. The Clean Water Act gives the government authority to require permits to limit pollutants in effluents. This statute prohibits all discharges of pollutants through a point source unless the polluter has an NPDES (National Pollutant Discharge Elimination System) permit. Nonpoint pollution sources are handled through 208 planning, a process required by the Act which has received low priority from all involved. Each governor is required to designate areas in the state with substantial water quality control problems and select an areawide planning agency for each designated area. In the courts, many polluters argue that their form of pollution is not a point source. The Clean Water Act allows nonpoint sources to be defined as drainage from agricultural and silvicultural activities, including runoff from fields and crop and forest lands. The case of Sierra Club V. Abston Construction Co., Inc. contained legal arguments concerning when a nonpoint source of pollution becomes a point source. Some problems in developing and enforcing a permit system for agricultural drainage are discussed. (See also W88-05654) (Geiger-PTT)
W88-05672

**LEGAL, ECONOMIC AND POLITICAL CONSTRAINTS ON MANAGING AGRICULTURAL DRAINAGE WATER IN CALIFORNIA,**
Westlands Water District, Fresno, CA.
W. R. Johnston, and M. G. Heaton.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 188-195, 1 fig, 15 ref.

Descriptors: *Agricultural runoff, *Water pollution sources, *Water pollution prevention, *Water law, *California, Jurisdiction, Subsurface drainage, Legal aspects, Economic aspects, Political aspects, Saline water, Drainage effects, Wastewater disposal, Irrigation water, Water pollution control.

The legal, economic, political and environmental problems of disposal of subsurface saline agricultural drainage water in the San Joaquin Valley of California are discussed. Historical events leading up to these problems include: the 1960 Congressional authorization of irrigation and drainage facilities; the partial construction of the authorized facilities; the construction of a drainage collector system to serve 42,000 acres of land in Westlands Water District; the accumulation of drainage water flows in Kesterson Reservoir; the indications of

environmental problems at Kesterson; the February 1985 order by the State Water Resources Control Board to the Bureau of Reclamation to clean up or close Kesterson; and the subsequent decision by the Department of the Interior to terminate the flow of drainage water into Kesterson. This situation has created a set of problems in the management and disposal of subsurface drainage water produced in Westlands Water District and other areas of the valley. A brief analysis of the difficulty of finding acceptable solutions to this set of problems is presented. The problems are primarily due to the multiplicity of constraints caused by: the overlapping jurisdictions of several local, state, and federal agencies; the absence of a specific set of regulations which are clearly applicable to agricultural drainage water; and the competition between economic, political and environmental factors. (See also W88-05654) (Author's abstract)
W88-05673

**SURFACE WATER AND GROUNDWATER REGULATION AND USE: AN ETHICAL PERSPECTIVE,**
Southern Illinois Univ. at Carbondale. Dept. of Agribusiness Economics.
S. E. Kraft.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 198-206, 28 ref.

Descriptors: *Water use, *Water law, *Reasonable use, Groundwater management, *Ethics, Legal aspects, Economic aspects, Social aspects, Management planning, Water costs, Water management, Nonconsumptive use, Consumptive use, Political aspects, Decision making, Water policy.

Existing case law, statutory regulation, and legal writing on water resources is a conglomeration of themes derived from common law, economic theory, legal theory, and descriptive ethics informed by past and present social mores. While utilitarianism and a world view in which nature is seen as immutable has become ingrained in our legal foundation, technology now raises ethical problems and economic issues that undermine at least part of this legal foundation. Some of these ethical problems and economic issues are described and related to existing and emerging water resources law and litigation. The ethical theories of Hans Jonas and John Rawls are discussed in relation to such topics as reasonable use, water use efficiency, water costs, and environmental impacts of water use. Jonas argues that the ethics of the past are inappropriate for decision making in the present and future because of the impact of today's decisions on the future. A basic ethical component of contemporary society informing the use of water resources is utilitarianism. Utiliarianism also informs much of the case law and legal writing used in the litigation of water related issues. This core of tradition is in potential conflict with recent legislation that embodies a gradual departure from utilitarianism and the acceptance of an ethical view calling for actions taken in the present which do not degrade future human life. The reconciliation of these two perspectives within the judicial and legislative arenas remains a challenge not only for managers of water resources but for society as a whole. (See also W88-05654) (Geiger-PTT)
W88-05674

**ADAPTING SURFACE WATER LAW TO ATMOSPHERIC WATER RESOURCES TECHNOLOGY,**
Brigham Young Univ., Provo, UT. J. Reuben Clark Law School.
R. J. Davis.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 207-215, 36 ref.

Descriptors: *Cloud seeding, *Water law, *Permits, *International law, *Weather modification, *Interbasin transfers, Liability, Financing, Water rights, Riparian rights, Legal aspects, International agreements, Surface water, Water policy, Water mangement.

Lawmakers have often borrowed surface water law when resolving legal problems arising from use of new technology to develop other portions of the hydrologic cycle. As cloud seeding technology becomes more developed, laws governing it will most likely be adapted from surface water law. The extent to which surface water law has been adapted to issues raised by advancing weather management capabilities are explored. Permits for weather modification projects are required in most jurisdictions containing permit systems for surface water projects. Permit applicants file a form listing the names of the applicant and the weather modifier conducting the proposed project, the target area sought to be treated by cloud seeding, the seeding mateials which will be used, the method of dispersion of those materials, and the time for which the permit is sought. There are relatively few liability cases concerning atmospheric water resources development, due mostly in part for lack of proof of damages caused by such activities. Some states still maintain statutory liability provisions concerning weather modification activities. Funding for atmospheric water resources development has come from public agencies with government monies, and from elected agencies which raise money through mill levies and assessments to benefit the areas they represent. There are no federal laws allocating interstate atmospheric water rights, no interstate compacts dividing atmospheric water among states, and no litigation between states because of cloud seeding the atmosphere in an upwind jurisdiction. Some states deny permits to seed to affect targets in other states, while other states cooperate in giving permits for out-of-state targets. There are some international weather modification agreements which follow surface water models. Efforts have also been made through the United Nations to make international law regarding multinational weather resources management. (See also W88-05654) (Geiger-PTT)
W88-05675

**HYDROLOGY AND WATER LAW-COOPERATION FOR THE FUTURE,**
Hardt (W.F.) and Associates, Orange, CA.
W. F. Hardt.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 216-224, 13 ref.

Descriptors: *Water law, *Interagency cooparation, *Legal aspects, *Groundwater management, *Water rights, Computer models, Data interpretation, Water allocation, Riparian rights, Water use, Mathematical models, Water policy, Decision making, Economic aspects.

Many of today's water laws are resented by some water experts because they may serve as barriers to management efforts based on modern scientific understanding. The law provides one basis by which society allocates water resources among alternative uses. The Eastern United States generally followed the riparian doctrine whereby water rights attach to the ownership of land abutting or overlying the water. The Western United States developed the prior appropriations concept of water rights, based largely on the reality that few surface water streams were available for supplying water. State and federal water laws and administrative regulations can be improved in the future if the role of hydrology is enhanced by the close cooperation of lawmakers, water managers, and hydrologists. Water scientists are generally weak at the policy making level where major decisions, regulations, and laws involving water are made. Computer models of hydrologic systems have many weaknesses that can limit their usefulness in legal matters. If the hydrologic data requirements needed by the lawmakers are precisely defined and the hydrologists provide input in clarifying hydrologic systems, concepts, and problems, then more meaningful laws that closely relate to the natural dynamics of the physical system as modified by man's activities will be realized. The economic aspects of water marketing and water ownership are discussed. (See also W88-05654) (Geiger-PTT)
W88-05676

**REGULATING AGRICULTURAL SURFACE WATER MANAGEMENT IN FLORIDA: THE IMPLEMENTATION OF CHAPTER 373, PART IV,**
Spessard L. Holland Law Center, Gainesville, FL.
R. Hamann, and J. Wade.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 225-234, 14 ref.

Descriptors: *Marsh management, *Florida, *Drainage effects, *Environmental impact statement, *Water law, *Water districts, Wetlands, Environmental protection, Legal aspects, Environmental effects, Ecological effects, Water management, Permits, Legislations.

The problems associated with the drainage and clearing of wetlands in Florida and the legislation designed to stop destruction of the wetlands are discussed. Until 1984, the statutory framework did little to slow the rate at which wetlands in Florida were being converted to agricultural land. The Warren S. Henderson Wetlands Protection Act of 1984 gave the state authority over all surface water dredge and fill activities. The Florida Water Resources Act of 1972 divided Florida into five regional water management districts (WMDs), each governed by a 9-member board appointed by the governor. Part IV of Chapter 373 of the Act deals with the regulation of surface water management systems, and requires a permit for the construction, alteration, maintenance and operation of most real property improvements designed to control or impound surface waters. Recently enacted legislation, Florida Statute 373.414, requries the WMDs to adopt rules to cover isolated wetlands. The rules must contain criteria for review of fish and wildlife, including habitats; criteria for protection of threatened and endangered species in isolated wetlands, regardless of wetland size and land use; consideration of cumulative and offsite impacts of a project; and size thresholds for isolated wetlands that are considered so small that fish and wildlife values need not be evaluated for a permit. If restrictive, protective criteria are adopted, the WMD faces the additional task of funding the staff and expertise required to fully implement those rules. (See also W88-05654) (Geiger-PTT)
W88-05677

**SUSTAINED GROUNDWATER YIELD AND CONSUMPTIVE USE VIA TARGET LEVELS IN A REASONABLE USE STATE,**
Arkansas Water Resources Research Center, Fayetteville.
A. W. Peralta, and R. C. Peralta.
IN: Water Resources Law, Proceedings of the National Symposium on Water Resources Law, December 15-16, 1986, Chicago, Illinois. 1986. p 235-243, 1 fig, 1 tab, 15 ref.

Descriptors: *Reasonable use, *Consumptive use, *Groundwater management, *Water law, *Conjunctive use, *Arkansas, Reasonable use, Legal aspects, Water use efficiency, Water yield, Groundwater mining, Water management, Water policy, Computer models, Hydrologic models, Regional analysis, Water rights, Riparian rights.

Groundwater and surface water regional models can be created to develop water use strategies that maximize achievement of predetermined regional objectives. In addition, the water use strategies developed by such planning models can: assure the sustained availability of groundwater; make best use of surface water resources while they are available for recharge to an aquifer or for diversion to riparian or nonriparian lands; and successfully coordinate the use of groundwater and surface water resources that hydrologically interact with each other. Implementing a sustained yield groundwater management strategy that can sustain approximately the same amount of pumping year after year at each pumping location will ultimately result in the development of a 'steady-state' water table, piezometric or potentiometric surface. Let 'potentiometric surface' refer to the water table or piezometric surface. This steady-state potentiometric surface is a 'target' surface that, when properly designed,

assures: adequate saturated thicknesses for existing or planned wells; adequate saturated thickness to permit additional groundwater pumping in time of drought; and movement of an 'appropriate' amount of water between the district's aquifer and connected aquifers or streams. In summary, water users adhering to such a groundwater management strategy should enjoy some degree of protection from successful litigation charging 'unreasonable use'. Furthermore, the use of diverted river water can be coordinated with the sustainable use of groundwater to maximize the total use of available water. There is not now any major legal impediment to conjunctive use of groundwater and surface water in Arkansas. It is hoped that future acts of the legislature, courts and administrative agencies will preserve presently existing options. (See also W88-05654) (Author's abstract)
W88-05678

**WATER RIGHTS: SCARCE RESOURCE ALLOCATION, BUREAUCRACY, AND THE ENVIRONMENT.**
Pacific Institute for Public Policy Research, San Francisco, California. 1983. 348 p. Edited by Terry L. Anderson.

Descriptors: *Water rights, *Water law, *Water allocation, *Groundwater management, *Riparian rights, Irrigation efficiency, Water use, Water costs, Property rights, Water pollution control, Political aspects, Water policy, Economic aspects, Decision making, Rents, Pricing, Arid lands, Appropriation, Water transfer.

The allocation of resources to productive purposes always involves both market and political considerations. This book compiles papers providing useful lessons on the allocation of agricultural and urban water supplies in the United States. To understand the papers in this volume, it is useful to recognize the emerging new resource economics paradigm which blends the economics of property rights, entrepreneurship and public choice. Chapters discussing property rights and decision making include the following topics: appropriators versus expropriators - the political economy of water in the West; the federal reclamation program - an analysis of rent-seeking behavior; and water pricing and rent seeking in California agriculture. Chapters on institutions and institutional reform include the following topics: water in Colorado - fear and loathing of the marketplace; institutional restrictions on the transfer of water rights and the survival of an agency; and the economic determinants and consequences of private and public ownership of local irrigation facilities. Chapters on privatization include the following topics: privatizing groundwater basins - a model and its application; instream water use - public and private alternatives; and building markets for tradable pollution rights. This volume is intended to set the agenda for future research. Applications of the new resource economics paradigm are necessary if water policy is to move toward improved efficiency. (See W88-05680 thru W88-05688) (Geiger-PTT)
W88-05679

**APPROPRIATORS VERSUS EXPROPRIATORS: THE POLITICAL ECONOMY OF WATER IN THE WEST,**
University of West Florida, Pensacola. Dept. of Political Science.
A. G. Cuzan.
IN: Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment. Pacific Institute for Public Policy Research, San Francisco, California. 1983. p 13-43, 1 tab.

Descriptors: *Water rights, *Water allocation, *Appropriation, *Western United States, *Water law, Legal aspects, Political aspects, Economic aspects, Water policy, Riparian rights, Models, Water costs, Property rights, Water demand, Navigation.

Arguments are made to show that the internal laws that regulate the political means necessarily promote centralization and bureaucratization of the water industry. John Locke's positive theory of property are applied to water appropriation. As resources held in common become more scarce, the most enterprising members of the community apply their labors to enclose and put them to use. In order to minimize the cost of disputes over title or the size of possession, the appropriators reach agreement on two fundamental rules for dividing the commons: priority of right acquired by virtue of discovery or possession, and a person's right is limited to what he puts to beneficial use. The evolution of water law at the state level resulted in the initiation of permit programs. The transformation of a system of water rights acquired independently of the government into one of permits secured from a state bureaucracy undermines the security of titles, making it difficult to transfer water to its most productive uses. This system increased the unreliability of water supply, prevented the integration of irrigation works and river systems, and led to a cumbersome structure of regulations and decrees. In the late 1800's Major Powell initiated massive irrigation programs backed by the federal government in the west. Many reclamation projects were thwarted by the navigation acts that asserted federal control over navigable rivers and all their tributaries on the basis of the commerce clause of the Constitution. Several conslusions are drawn from a comparative study of the political histories of the Bureau of Reclamation and the Department of Water and Power of the City of Los Angeles. Currently, federal and state governments are under pressure to engage in large scale projects to reappropriate water resources in the West or increase bureaucratic controls for the withdrawal of groundwater. (See also W88-05679) (Geiger-PTT)
W88-05680

**FEDERAL RECLAMATION PROGRAM: AN ANALYSIS OF RENT-SEEKING BEHAVIOR,**
Washington Univ., Seattle. Dept. of Economics.
R. R. Rucker, and P. V. Fishback.
IN: Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment. Pacific Institute for Public Policy Research, San Francisco, California. 1983. p 45-81, 2 tab.

Descriptors: *Irrigation programs, *Land reclamation, *Marketing, *Water law, *Loans, *Rent-seeking behavior, Appropriation, Legal aspects, Economic aspects, Financing, Water policy, Federal jurisdiction, Water allocation, Marketing techniques.

The actions of irrigators and bureaucrats who competed to obtain rents from federal water projects within constraints imposed by Congress are analyzed. In the Reclamation Act of 1902, potential water users obtained federal subsidies in the form of interest-free loans for the construction costs of irrigation works. The distribution of rents among landowners was determined by acreage limitations and rules for the disposal of public and private lands. According to the 1902 act settlers could obtain the rent on public lands by settling those lands under the Homestead Act. These rents were dissipated by the settlement of project lands prior to the delivery of irrigation water. To reduce dissipation and increase the financial success of projects, Congress passed laws restricting early settlement and eventually gave the Bureau of Reclamation increased discretionary power over who settled the public lands. Under the 1902 act Congress tried to ensure the dissolution of large landholdings by allowing private landowners to sell their excess lands at market prices. Congress gave the Secretary of Interior discretionary power to set the selling price of excess lands. In 1926 Congress tried to restrict the secretary's discretionary power and limit the subsidy to large landowners, but the bureau found new ways to control the subsidy's distribution. Large landowners continually applied pressure for exemptions to the acreage limitation law, while congressional pressure for enforcement of the law varied over time. This description of the first five decades of the federal reclamation program demonstrates how efforts were made to influence the magnitude and distribution of the subsidies from this particular government program. Whenever rents are created by government programs and distributed on the basis of non-market criteria, competition will lead to dissipation of those rents. (See also W88-05679) (Geiger-PTT)
W88-05681

**WATER PRICING AND RENT SEEKING IN CALIFORNIA AGRICULTURE,**
California Univ., Davis. Dept. of Agricultural Economics.
B. D. Gardner.
IN: Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment. Pacific Institute for Public Policy Research, San Francisco, California. 1983. p 83-116.

Descriptors: *Water costs, *Pricing, *Irrigation practices, *California, *Water use, *Rent seeking, Water rights, Water law, Marketing, Water yield, Irrigation efficiency, Water allocation, Appropriation, Irrigation programs, Economic aspects, Prices, Crop yield, Water management.

California has relied heavily on irrigation to make it the highest producing agricultural state in the nation. In California, as in many other states in the West, water has been priced below its true economic value in use, providing access to enormous magnitudes of economic rent. Water prices and use rates in California agriculture demonstrate through an elasticity of demand that farmers are price responsive in their use of irrigation water. An empirical analysis of the main types of responses to higher water prices is given. These responses include: using less water on a given crop; changing irrigation technology; shifting water applications to more water-efficient crops; and changing crop mix to higher valued crops. The water-allocating institutions in California are discussed in relation to how their pricing and allocating rules misallocate water. The implications of this misuse for the distribution of economic rents in the state are also examined. (See also W88-05679) (Geiger-PTT)
W88-05682

**WATER IN COLORADO: FEAR AND LOATHING OF THE MARKETPLACE,**
T. D. Tregarthen.
IN: Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment. Pacific Institute for Public Policy Research, San Francisco, California. 1983. p 119-136, 1 tab.

Descriptors: *Colorado, *Marketing, *Water allocation, *Pricing, *Water costs, Water policy, Water rights, Water management, Consumptive use, Beneficial use, Profit, Risks, Appropriation, Water law, Property rights, Decision making, Judicial aspects.

Prior appropriation doctrine provides for a system of property rights that could form the basis for a reasonably efficient allocation of water. But, as applied in Colorado, several difficulties exist. Defining rights as rights to divert but permitting transfers based on adversarial proceedings to determine consumptive use, increases transactions and information costs and creates a perverse set of incentives against conservation. The doctrine of beneficial use creates unnecessary uncertainty in the title to rights. The judicial distaste for profit reduces the opportunity for profit-seeking firms to assume risks in developing water and seeks to unify ownership of common property resources. Colorado's prior appropriation doctrine, the central feature of which is a private market for rights in water, thus poses an intriguing dilemma. The courts that regulate this market have exhibited, in ruling after ruling, a fundamental lack of confidence in the efficacy of private-market solutions. The result is a needlessly costly and uncertain system in which innovation is difficult. The fear and loathing of the private market under prior appropriation doctrine, of course, does have one other significant result - a greatly expanded role for the judicial system that administers it. The relatively simple steps of defining and recording existing rights in terms of consumptive use, leaving to the market the issue of what sorts of uses are beneficial, would significantly enhance the ability of the private market to serve the interests of consumers of water in Colorado. (See also W88-05679) (Author's abstract)
W88-05683

**INSTITUTIONAL RESTRICTIONS ON THE TRANSFER OF WATER RIGHTS AND THE SURVIVAL OF AN AGENCY,**
New Mexico Univ., Albuquerque. Dept. of Economics.
M. Gisser, and R. N. Johnson.
IN: Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment. Pacific Institute for Public Policy Research, San Francisco, California. 1983. p 137-165, 1 fig, 2 tab, append.

Descriptors: *Water rights, *Water law, *Water transfer, *New Mexico, *Water allocation, *Water districts, Appropriation, Legal aspects, Economic aspects, Marketing, Consumptive use, Reasonable use, Water policy, Water management, Water costs.

Throughout the United States, conservancy districts frequently place broad restrictions on the transfer of water rights. New Mexico's Middle Rio Grande Conservancy District (MRGCD) has refused to approve the transfer of water rights from within the district to points outside its boundaries. The general objections to transfer as well as those specific to the MRGCD are considered. A conceptual framework for analyzing externalities in water transfers is given. The justification of restrictions on transfers on the basis of ill-defined rights is shown to depend on whether rights are defined on the basis of consumptive use and whether there are ample checks against potential third-party impairments. The derived criteria for a well-defined property rights sytem is compared to the rules and regulations pertaining to transfer in the state of New Mexico, where it appears that the necessary conditions for a well-defined system have been met. An explanation of why the MRGCD restricts transfer of water is proposed. Water users within the district boundaries have historically been viewed by the conservancy as having the right to use water but not to transfer it. Agencies such as conservancy districts provide a form of collective action but appear to have their own set of costs. Restrictions on transfer can be expected to reduce allocative efficiency and increase the cost of development while members of the agency become the prime beneficiaries. (See also W88-05679) (Geiger-PTT)
W88-05684

**ECONOMIC DETERMINANTS AND CONSEQUENCES OF PRIVATE AND PUBLIC OWNERSHIP OF LOCAL IRRIGATION FACILITIES,**
Chicago Univ., IL. Dept. of Economics.
R. T. Smith.
IN: Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment. Pacific Institute for Public Policy Research, San Francisco, California. 1983. p 167-217, 8 fig, 8 tab, 2 append.

Descriptors: *Irrigation programs, *Irrigation district, *Water rights, *Water law, *Water allocation, *Institutional constraints, Appropriation, Economic aspects, Legal aspects, Riparian rights, Water transfer, Pricing, Water demand, Beneficial use, Water management, Marketing, Water costs, Risks, Rents, Econometrics.

Resource use under the rules of the mutual irrigation company possesses many desirable properties from the viewpoint of original landowners in an area. The rules guarantee the subscription of farmers to the mutual company that financed construction of irrigation facilties without any elements of monopoly pricing of irrigation water. The tradable nature of water rights, and their ability to be rented during either dry or wet years, create important risk-spreading opportunities for risk-averse farmers, which improves the attractiveness of an agricultural area for settlement. The magnitude of the increased attractiveness from the use of the mutual irrigation company is greatest in areas with higher variance in the supply of appropriated water and less elastic short-run demands for water. Both of these considerations increase the productivity of stock ownership in reducing the variance in total income. The competitive entry of farmers into an area guarantees that the original landowners capture all of these benefits of pursuing irrigation development under the rules of the mutual irrigation company. A theory of resource allocation under public ownership and an econometric analysis of irrigation water use and choice of ownership in California are given. The effect of irrigation development on land values and the median voter model of water subsidization are discussed in the appendices. (See also W88-05679) (Author's abstract)
W88-05685

**PRIVATIZING GROUNDWATER BASINS: A MODEL AND ITS APPLICATION,**
Montana State Univ., Bozeman. Dept. of Economics.
T. L. Anderson, O. R. Burt, and D. T. Fractor.
IN: Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment. Pacific Institute for Public Policy Research, San Francisco, California. 1983. p 223-248, 2 fig, 3 tab.

Descriptors: *Water rights, *Groundwater management, *Water allocation, *Model studies, *California, Property rights, Water law, Water costs, Prices, Economic aspects, Pricing, Reasonable use, Water transfer, Water management, Appropriation, Privatization.

An agenda for institutional reform is provided that will improve groundwater allocation. A survey is given of the institutions and property rights that govern groundwater. A model elucidating the problems of allocating groundwater across time and space us used to develop a system for privatizing groundwater rights that allows for the decentralization of allocation decisions. The model develops the economic conditions necessary for optimal allocation of groundwater in a basin that has both a stock and flow component. This institutional arrangement is applied to the Tehachapi groundwater basin in California, and the results of privatization are compared with those of existing institutions. Establishing both stock and flow rights to groundwater has the potential for eliminating the inefficient use of groundwater and reducing centralized information requirements. With the increasing scarcity of surface water and groundwater, privatizing the commons offers the most hope for obtaining the highest value from these resources. (See also W88-05679) (Geiger-PTT)
W88-05686

**INSTREAM WATER USE: PUBLIC AND PRIVATE ALTERNATIVES,**
Lewis and Clark Coll., Portland, OR. Natural Resources Law Inst.
J. Huffman.
IN: Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment. Pacific Institute for Public Policy Research, San Francisco, California. 1983. p 249-282.

Descriptors: *Water use, *Water law, *Instream water use, *Water allocation, *Water rights, *Minimum flow, Water demand, Institutional constraints, Case studies, Riparian rights, Public policy, Water policy, Water management, Economic aspects, Washington, Idaho, Montane, Appropriation, State jurisdiction, Legal aspects, Water costs.

Most state water laws give the states the primary role in the allocation of water to instream uses. This chapter examines the validity of the presumption that state intervention is beneficial based upon in-depth studies of four state approaches to the allocation of water to instream flows. The most obvious form for government action to protect instream flows is regulation of water use. A second alternative is to pose conditions on newly acquired or transferred water rights. A third approach involves the reservation of unappropriated water from future appropriation. Finally, a state may rely on the public trust doctrine to protect instream flows. A state may acquire water through appropriation, purchase, and eminent domain. The history and nature of people's interests in minimum streamflow maintenance are briefly examined. The constraints that the private rights system has placed upon the private and public provision of instream uses are described. Some of the basic approaches that states have used to overcome these constraints are enumerated. Three case studies of state instream flow programs are examined. Idaho sets minimum flows by statute. Washington sets flows by bureaucratic expertise. Montana sets flow levels by reserving water. The prospects for the allocation of water to instream flows through a purely private system of water rights are considered. (See also W88-05679) (Geiger-PTT)
W88-05687

**BUILDING MARKETS FOR TRADABLE POLLUTION RIGHTS,**
Clemson Univ., SC. Dept. of Economics.
M. T. Maloney, and B. Yandle.
IN: Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment. Pacific Institute for Public Policy Research, San Francisco, California. 1983. p 283-320, 3 tab.

Descriptors: *Marketing, *Pollution taxes, *Water rights, *Water quality control, *Model studies, Effluent charges, Water quality standards, Water costs, Legal aspects, Riparian rights, Wastewater disposal, Economic aspects, Water allocation, Water pollution prevention, Rent-seeking behavior.

The development of water quality control in the United States is examined with a focus on the emergence of tradable pollution rights. Federal involvement in this area first appeared in 1948 with the creation of the Ohio River Valley Water Sanitation Commission lobbied in Congress for the enactment of federally-enforced pollution control measures along the Ohio River. A model is proposed to explain the theories of propreny rights and special-interest groups that brought about the allocative institutions for pollution rights. An understanding of property rights reveals that the cost of monitoring use is a crucial factor in shaping the institutions of environmental quality control. A special-interest theory of government regulations suggests possible coalitions between various special-interest groups. From this combination theory it is concluded that monitoring of water quality is a difficult problem because each of the many permutations of water users within a particular system yields a unique distribution of water quality. Given this monitoring problem, it is costly to allow a discharger of wastes at one site to sell pollution rights to a discharger at another location. The potential gains from such transfers are reduced, since rights to environmental use have been vested in each site permitted for pollution. While confined to specific locations, these rights are alienable through the transfer of land. Special-interest groups can delay the evolution of tradable rights and terminate markets with regulations. The most prominent special-interest effect in the law has been the enormous federal subsidy for municipal sewage treatment facilities. The rent-seeking behavoir of special-interest groups may distort the development of property rights. Some perspectives on the future of water quality control are presented. (See also W88-05679) (Geiger-PTT)
W88-05688

**NEW PERSPECTIVES ON POLLUTION CONTROL: CROSS-MEDIA PROBLEMS.**
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 5G.
W88-05691

**CONTROLLING CROSS-MEDIA POLLUTANTS.**
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 5G.
W88-05692

**SETTLING THINGS: SIX CASE STUDIES IN ENVIRONMENTAL MEDIATION,**
Conservation Foundation, Washington, DC.
A. R. Talbot.
The Conservation Foundation, Washington, DC. 1983. 101 p.

Descriptors: *Water law, *Water management, *Water resources development, *Decision making,

*Competing use, Evaluation, Project planning, Multiobjective planning, Projections, Environmental effects, Management planning, Environmental impact statement.

Throughout the past decade, environmental mediation has demonstrated success in resolving controversial environmental and resource issues. Six environmental disputes that were settled with mediation are documented. The first case involved a 17-year legal battle among three environmental groups, four public agencies, and five electric utility companies over the use of the Hudson River. The outcome of the mediation included the elimination of plans to construct Storm King power plant, endowment of a research program on the aquatic life in the Hudson River, and a provision that the utilities will not have to construct proposed cooling towers that would have been expensive to operate. In the second case, mediation that solved a dispute over the extension of Interstate 90 across Lake Washington and into Seattle helped three city councils, the county council, the regional sewer and transit agency, and the state highway department to sign an agreement. This agreement subsequently withstood legal challenge by local environmental groups not satisfied with the outcome on the adequacy of the environmental impact statement. In the third case, mediation helped solve disputes between a small-scale hydroelectric developer and Swanvill, a lakefront town in Maine. Through negotiations the parties involved agreed on a compromise that included minimum and maximum lake levels and the establishment of a local committee that would work out a plan for maintaining a small park adjacent to the Swan Lake Dam. In the Portage Island case the Whatcom County Park Board was set against the Lummi Indian tribe, on whose reservation the island was located. Negotiations between the park board and the tribe resulted in an agreement that called for the tribe to repurchase the island from the park board, with a commitment to manage the island as a public park. In the Eau Clair, Wisconsin case two municipalities ratified an agreement that allowed Eau Claire to locate its landfill in Seymour. In a final case, a mediator helped the residents of Port Townsend, Washington agree on a location for a new ferry terminal. (Geiger-PTT)
W88-05693

**GUIDELINES FOR PLANNING COMMUNITY PARTICIPATION ACTIVITIES IN WATER SUPPLY AND SANITATION PROJECTS,**
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 6B.
W88-05698

**OUR NATIONAL WETLAND HERITAGE: A PROTECTION GUIDEBOOK,**
J. A. Kusler.
An Environmental Law Institute Publication, Washington, DC. 1983. 167 p, 17 fig, 10 tab, 52 ref, 5 append.

Descriptors: *Wetlands, *Conservation, *Legal aspects, *Symposium, *Public participation, Literature review, Case studies, Management planning, Statutes, Regulations, Legislation, Federal jurisdiction, State jurisdiction, Public participation.

A guidebook consisting of literature review, an examination of State wetland statutes and programs, a survey of local wetland protection programs, an examination of all reported wetland cases, the papers presented at the first National Wetland Symposium in 1977, and many interviews with scientists, lawyers, engineers and others is presented. Chapters 1 and 2 discuss the need to protect and manage wetlands, threats to wetlands, and wetland origins and characteristics. Chapters 3, 4 and 5 identify management principles and standards, wetland protection techniques, and procedures for evaluation of development proposals. Chapters 6, 7, and 8 consider Federal, State and local regulatory efforts. Chapter 9 addresses legal issues in wetland regulation. Chapters 10 and 11 consider nonregulatory management techniques and the role of the private sector in wetland protection. The Appendices include a draft wetland protection ordinance, examples of wetland protection ordinances, a guide to federal programs which affect wetlands, a list of endangered animal species dependent on wetlands, and examples of deed restrictions. (Lantz-PTT)
W88-05703

**FURTHER ADVICE ON EXECUTIVE ORDER 11988 FLOODPLAIN MANAGEMENT.**
Interagency Task Force on Floodplain Management, Washington, DC.
For primary bibliographic entry see Field 6F.
W88-05704

**POLICIES RELATING TO GROUNDWATER AND BIOFOULING,**
Environmental Protection Agency, Atlanta, GA. Region IV.
J. E. Ravan.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 1-5.

Descriptors: *Aquifer characteristics, *Groundwater pollution, *Biofouling, *Groundwater quality, *Water quality management, Management planning, Public policy, Costs, Drinking water, Water supply, Fouling.

The growing problem of groundwater contamination has greatly challenged the ingenuity and institutional capacity of government at all levels. For many reasons, protecting groundwater is substantially more difficult than protecting air and surface water. In August 1984, EPA released its Ground Water Protection Strategy. Overall the Strategy was designed to rationalize and better use the many statutes EPA has for protecting groundwater. Thus, it focused on achieving four broad objectives: to enhance State programs, to deal more effectively with groundwater problems of major national concern, to create a policy framework for guiding EPA programs, and to strengthen EPA's internal groundwater organization. The following three-class system was set up to help define EPA management strategies that reflect the use, value and vulnerability of the resource: Class I is defined as 'special groundwater; Class II is defined as current and potential sources of drinking water and waters having other beneficial uses; and Class III is defined as groundwater not considered a potential source of drinking water and of limited beneficial use. Extensive economic costs exist and will continue to exist because of these organisms. Basic problems include the following: (1) Increased cost of pumping due to aquifer, screen and pump clogging; (2) Loss of potable water supply; (3) Deterioration of water quality; (4) Continuing frequent maintenance expense, including cost of manpower, cost of equipment, and cost of chemicals; (5) Frequent replacement of pumping and distribution components; (6) Replacement of water source (if possible); (7) Treatment of water from contaminated source; and (8) Loss of local industry from poor water quality. (See also W88-05724) (Lantz-PTT)
W88-05725

**LOW-LEVEL RADIOACTIVE WASTE REGULATION: SCIENCE, POLITICS AND FEAR.**
For primary bibliographic entry see Field 5E.
W88-05805

**FEDERAL ACTIVITIES RELATED TO THE TREATMENT OF DRINKING WATER,**
Department of National Health and Welfare, Ottawa (Ontario).
For primary bibliographic entry see Field 5F.
W88-05810

**GUIDELINES FOR CANADIAN DRINKING WATER QUALITY,**
Department of National Health and Welfare, Ottawa (Ontario).
For primary bibliographic entry see Field 5F.
W88-05811

**DEVELOPMENT OF DRINKING WATER REGULATIONS FOR ORGANIC CONTAMINANTS IN THE UNITED STATES,**
Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5F.
W88-05812

**HEALTH ASPECTS OF IRRIGATION DEVELOPMENTS,**
Southampton Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W88-05839

## 6F. Nonstructural Alternatives

**SURFACE WATER FEES USED TO REDUCE URBAN FLOODING,**
King County Dept. of Public Works, Seattle, WA.
L. Ferrari.
Public Works PUWOAH, Vol. 118, No. 8, p 66-67, August, 1987.

Descriptors: *Urban areas, *Flooding, *Flood protection, *King County, WA, *Urban drainage, *Public policy, Protection, Rainfall, Runoff, Drainage, Economic aspects, Public opinion, Public participation, Environmental policy, Land use, Administrative agencies.

Seattle's Department of Public Works Surface Water Management (SWM) Division has developed a comprehensive program to solve existing stormwater drainage problems, prevent future problems, and protect the natural drainage system. A total of 260 capital improvements costing about $65 million were identified, and 34 projects were targeted for construction over a three-year period at a cost of $8 million. A survey indicated that many King County residents were willing to pay an annual fee to support the program. The service charge rate structure is based on the amount of impervious surfaces on developed property, which is then used as an equitable measure of the property owner's contribution to runoff problems. The areas charged include only the developed properties in 38 of the 72 drainage basins in the county. The current fee structure for residential property owners is $29.89 per year. The comprehensive program will generate an estimated $8.4 million annually. Capital improvement revenues will be applied only to those areas paying the fee, and special emphasis will be placed on areas characterized by urban development or expected future growth. Maintenance funds will allow the county to undertake a complete routine maintenance program. There are also programs to increase citizen awareness. (Doria-PTT)
W88-05650

**WATER DUTY: BASIS FOR WATER ALLOCATION,**
Arizona Univ., Tucson. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 6E.
W88-05657

**ZONING TO PROTECT GROUNDWATER QUALITY,**
Wisconsin Univ.-Madison. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6E.
W88-05664

**PROTECTING FRESHWATER INFLOWS INTO TEXAS ESTUARIES: AN EVALUATION OF LEGAL STRATEGIES,**
Texas A and M Univ., College Station. Inst. of Renewable Natural Resources.
For primary bibliographic entry see Field 6E.
W88-05667

**FURTHER ADVICE ON EXECUTIVE ORDER 11988 FLOODPLAIN MANAGEMENT.**
Interagency Task Force on Floodplain Manage-

ment, Washington, DC.
1987. 68 p, 1 fig, 11 ref, 3 append.

Descriptors: *Flood plain management, *Water Resources Council, *Standards, *Regulations, Legal aspects, Case studies, Legislation, Executive Ordens.

Through a discussion of specific and commonly recurring issues and examples, how to implement the provisions of Executive Order 11988, Floodplain Management, is illustrated. The Water Resource Council Floodplain Management Guidelines for implementing Executive Order 11988 were developed to provide broad guidance in the interpretation of the Executive Order and to assist each agency which would be developing its own individual procedures for compliance with the Executive Order. since the guideline's initial publication in 1978, questions, problems and issues, which were not foreseen or addressed, have arisen. This guidance document does not supplant, but supplements the still valid WRC Guidelines. This document has been divided into two principal parts. The first provides an interpretation on several issues which continue to present problems to those individuals responsible for implementing the Executive Order. The second represents a series of scenarios which illustrate how to address those issues when implementing the Executive Order. The scenarios have been grouped together to provide a broad spectrum of Federal actions in the context of the Executive Order. The categories of Federal actions range from those over which a Federal agency has direct control to those where responsibility has been delegated to local units of government. While the scenarios may appear to be addressing an action undertaken by a specific agency, they are intended to be generic and applicable to Federal agencies with similar responsibilities and programs. (Lantz-PTT)
W88-05704

## 6G. Ecologic Impact Of Water Development

**RESCUING THE EVERGLADES,**
South Florida Water Management District, West Palm Beach. Dept. of Resource Management.
For primary bibliographic entry see Field 4A.
W88-05475

**FISHING THE FOUR-LANE,**
Montana Dept. of Highways, Helena.
For primary bibliographic entry see Field 4C.
W88-05477

**MODELING TIDAL POWER,**
D. A. Greenberg.
Scientific American SCAMAC, Vol. 257, No. 5, p 128-131, November 1987. 8 fig.

Descriptors: *Tidal powerplants, *Environmental effects, *Dam effects, *Simulation, *Model studies, *Water level, Tidal energy, Environment, Powerplants, Bay of Fundy, Computer models, Economic aspects, Costs.

In order to generate power using the tides in the Bay of Fundy, a dam across part of the bay has been considered. At high tide, water would fill the reservoir behind the dam and after the tide receded, the water would be released through ordinary turbines. In order to study the possible environmental effects of such a dam, a computer model was developed. It suggests that a tidal power dam would cause a small increase in tide levels over a large area extending down the Gulf of Maine to Boston and Cape Cod. The exact environmental impact cannot be predicted by the model, but it is accurate enough for assessment of true costs of tidal power. (Wood-PTT)
W88-05500

**EFFECTS OF ACID RAIN ON FRESHWATER ECOSYSTEMS,**
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5C.
W88-05506

**REGULATING AGRICULTURAL SURFACE WATER MANAGEMENT IN FLORIDA: THE IMPLEMENTATION OF CHAPTER 373, PART IV,**
Spessard L. Holland Law Center, Gainesville, FL.
For primary bibliographic entry see Field 6E.
W88-05677

**CITIZEN'S GUIDE TO RIVER CONSERVATION,**
National Park Service, Boston, MA.
For primary bibliographic entry see Field 6A.
W88-05690

**DEVELOPMENT OF NONDESTRUCTIVE TESTING SYSTEMS FOR IN SITU EVALUATION OF CONCRETE STRUCTURES,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
For primary bibliographic entry see Field 8F.
W88-05700

**HISTORICAL ARCHAEOLOGICAL INVESTIGATIONS AT DAM CONSTRUCTION CAMPS IN CENTRAL ARIZONA: FIRST ANNUAL REPORT.**
Dames and Moore, Phoenix, AZ.
DOI Report No. DI-BR0APO CCRS 87-13, October 1987. 60 p, 12 fig, 7 tab, 25 ref. Edited by A. E. Rogge and Cindy L. Myers.

Descriptors: *Archaeology, *History, *Dam construction, *Arizona, Construction, Social impact, Damsites, Central Arizona Project.

In June 1986, the Bureau of Reclamation awarded a three-year contract for historical archaeological studies as part of the mitigation program for the Regulatory Storage Division (Plan 6) of the Central Arizona Project. This study focuses on reconstructing the social history of the workers and their families who lived in several temporary dam construction camps dating from the 1890s to 1940s. The first chapter discusses experience in managing the study during the first year of the project. The methods used to pursue archaeological fieldwork, laboratory analysis and historical research are described and evaluated in subsequent chapters. In the final chapter, preliminary research implications are summarized for each of the four research themes focusing the study: (1) camp demography; (2) daily living conditions in the camps, (3) the work environment; and (4) relationships among the many ethnic groups that came together in the camps. (Author's abstract)
W88-05701

**DOLORES ARCHAEOLOGICAL PROGRAM: FINAL SYNTHETIC REPORT.**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
Available from the National Technical Information Service, Springfield, VA. 22161 as PB88-130356. Price codes: A99 in paper copy, E04 in microfiche. December 1986. 900 p, 258 fig, 144 tab, 1144 ref, 4 append. Compiled by David A. Breternitz, Christine K. Robinson, and G. Timothy Gross. Bureau of Reclamation Contract No. 8-07-40-S0562.

Descriptors: *Archaeology, *Social aspects, *Dolores Archaeological Program, *Colorado, Prehistoric man, History, Water resources development, Reservoirs.

The Dolores Project is a large water impoundment project being constructed by the Bureau of Reclamation in southwestern Colorado. From 1978 until 1985, the University of Colorado contracted to mitigate the adverse impacts of the Dolores Project on the cultural resources in the project area. This volume presents the final synthetic work of this Dolores Archaeological Program. Included are analytical results, the prehistory of the Dolores area, and an assessment of Anasazi cultural dynamics from A.D. 600 to 980. (Author's abstract)
W88-05741

**DOLORES ARCHAEOLOGICAL PROGRAM: SUPPORT STUDIES: SETTLEMENT AND ENVIRONMENT.**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
Available from the National Technical Information Service, Springfield, VA. 22161 as PB88-150630. Price codes: A99 in paper copy; E04 in microfiche. March 1987. 709 p, 262 fig, 215 tab, 1079 ref, 8 append. Compiled by Kenneth Lee Patersen and Janet D. Orcutt. Bureau of Reclamation Contract No. 8-07-40-S0562.

Descriptors: *Archaeology, *Social aspects, *Dolores Archaeological Program, *Colorado, History, Water resources development, Reservoirs.

This volume presents some of the final results of the Dolores Archaeological Program Environmental Archaeology Group and the Settlement Archaeology Group. Six reports outline the development of vegetational and climatic reconstruction for the project area; 8 reports focus on the agricultural potential for the area; 6 reports discuss a number of diverse topics including faunal remains, Phaseolus remains, human bones, and unusual rocks and minerals; and finally, 5, reports on settlement archaeology and population deal with site type definitions, population measurements, subsistence and locational trends, and survey methodology. (Author's abstract)
W88-05742

**HOHOKAM SETTLEMENT ALONG THE SLOPES OF THE PICACHO MOUNTAINS: THE PICACHO AREA SITES, TUCSON AQUEDUCT PROJECT.**
Museum of Northern Arizona, Inc., Flagstaff.
Available from the National Technical Information Service, Springfield, VA. 22161 as PB88-147830. Price codes: A22 in paper copy; A01 in microfiche. Museum of Northern Arizona Paper 35, Volume 3, 1987. 464 p, 85 fig, 104 tab, 85 ref, 24 plates, 3 append. Edited by Richard Ciolek-Torrello. Bureau of Reclamation Contract No. 3-CS-30-00790.

Descriptors: *Archaeology, *Hohokam settlements, *Picacho Mountains, *Arizona, *Tucson Aqueduct, Water resources development, History.

This volume presents the results of field investigations of sites in Reach 2, the area south of the Picacho Mountains and north of Red Rock, Arizona. Studies focused on portions of a large early Classic period village with a small Colonial period component, the McClellan Wash site, and a large Colonial period hamlet, the Picaho Pass site. Investigations were also carried out at a large dry-farming site used for the exploitation of Agave and wild plants, a specialized resource procurement and processing site with numerous bedrock mortars and metates, a small Colonial and Early Classic period farmstead, and a pre-Classic period reservoir. These investigations revealed that the earliest occupation of the area was in the Archaic or late Pioneer period and the first evidence of major settlement was in the early Colonial period. New and larger settlements were founded in the early Classic period. Settlement peaked in the late Classic period when a large community was formed around a platform mount northeast of the study area. The Hohokam adaptation to this area was similar to that postulated for the Desert Branch of the Hohokam, with subsistence dependent on Cheno-ams, Agave, and wild plant foods. Little evidence of corn agriculture was present. (Author's abstract)
W88-05743

**ARCHEOLOGICAL EXCAVATION AT THE NAZE SITE (32SN246).**
North Dakota Univ., Grand Forks. Dept. of Anthropology.
Available from the National Technical Information Service, Springfield, VA. 22161 as PB88-143292. Price codes: A99 in paper copy; A01 in microfiche.

September 1987. 580 p, 116 fig, 105 tab, 469 ref, 7 append. Edited by Michael L. Gregg. Bureau of Reclamation Contract No. 4-CS-60-00630.

Descriptors: *Social aspects, *Archaeology, *Naze site, *Water resources development, History, Garrison Diversion Unit, North Dakota.

A project was conducted to partially salvage a portion of an archeological site that was slated for Garrison Diversion Unit project development. A 76 sq m block excavation within the 6 ha site area encountered five zones of stratified cultural deposits. Work focused on three primary zones where Early Plains Woodland, Middle Plains Woodland, Plains Village, and Protohistoric components were identified. An Early Plains Woodland lodge dating within the 550-410 B.C. time range was documented. Middle Plains Woodland artifacts and features deposited during the 40 B.C.-A.D. 70 time period were assigned to the Sonota complex. Plains Village materials resulted from site use between ca. A.D. 1100 and 1400. A few historic artifacts indicated occupation between 1750 and 1950 when the site locality was Yanktonai Dakota territory. Chapters of the report cover the physical setting of the site locality, the project research design, cultural features in the excavated area, and classes of materials that were recovered: ceramics, chipped stone flaking debris, stone tools, seeds, wood charcoal, vertebrate faunal remains, mollusk shells, fire-cracked rocks, and miscellaneous artifacts. (Author's abstract)
W88-05744

**HABITAT MANAGEMENT MODELS FOR SELECTED WILDLIFE MANAGEMENT PRACTICES IN THE NORTHERN GREAT PLAINS,**
National Ecology Center, Fort Collins, CO.
P. J. Sousa.
Available from the National Technical Information Service, Springfield, VA. 22161 as PB88-114319. Price codes: A09 in paper copy; A01 in microfiche. Bureau of Reclamation Report No. REC-ERC-87-11, June 1987. 180 p, 18 fig, 35 tab, 83 ref.

Descriptors: *Wildlife habitats, *Management planning, *Water resources development, *Ecological effects, *Waterfowl, *Birds, *Wildlife, *Northern Great Plains, Conservation, Wildlife management, Wetlands, Economic aspects, Habitat enhancement, Mathematical models, Model studies.

The effects of selected management actions in the Northern Great Plains on habitat for the gadwall, blue-winged teal, sharp-tailed grouse, Baird's sparrow, gray partridge, and muskrat, are discussed. Categories of management actions discussed include Land Acquisition (fee title, easement), Upland Vegetation Development (plant dense nesting cover, plant native grasses, woodland development), Upland Vegetation Maintenance/Management (prescribed burning), Upland Vegetation Protection (grazing control), Wetland Development (construct seasonal wetlands, construct semipermanent wetlands, restore drained wetlands), and Island Construction (nesting islands). Information provided for each action includes the purpose, effects of the action, maintenance and management, labor and materials, and a model describing the functional relationships between the action and selected habitat variables. (Author's abstract)
W88-05746

**HYDROLOGY AND WATER RESOURCES IN TROPICAL REGIONS,**
For primary bibliographic entry see Field 2A.
W88-05776

**STATE OF THE ENVIRONMENT: A VIEW TOWARD THE NINETIES.**
Conservation Foundation, Washington, DC.
The Conservation Foundation, Washington, DC. 1987. 614 p.

Descriptors: *Water pollution effects, *Species diversity, *Wildlife conservation, *Environmental impact statement, *Environmental protection, *Environmental policy, *Environmental effects, Population dynamics, Fate of pollutants, Pollutant identification, Risk assessment, Water pollution control, Water quality, Public policy.

Twice before in this decade, The Conservation Foundation has reviewed the United States' progress in improving the condition of its environment and the management of its natural resources. This report continues that focus with two important changes: It intentionally takes a long-term view of the nation's environmental picture in an effort to ask the questions and provide the information that policy makers and other concerned individuals will need as the nation approaches the 1990s. The report is divided into two parts. The first five chapters describe and analyze a wide range of environmental conditions and trends. Chapter 1 deals with such underlying trends as population, economic growth, public opinion, and environmental expenditures. Chapter 2 covers trends in conventional environmental pollutants in the air and water and on the land. Chapter 3 assesses the situation with toxic substances and hazardous and nuclear wastes. Chapter 4 summarizes what is happening to the use and condition of the nation's land, water, and energy resource. Chapter 5 deals with wildlife and such protected lands and critical areas as parks, wilderness, and wetlands. The second part of the report examines four environmental issues that are not being fully addressed by existing environmental protection and management programs. Chapter 6 assesses the problems facing the nation's agricultural sector and the interactions between agricultural production and environmental quality, both at home and abroad. Chapter 7 provides a broad overview of waste production and management in the United States. Chapter 8 evaluates the risks associated with three types of air pollution not being dealt with rigorously under current air pollution control laws: air toxics, indoor air, and accidental releases. Chapter 9 assesses the importance and implications of switching from past wildlife policies aimed predominantly at protecting individual species to expanded approaches addressing biological diversity. (Lantz-PTT)
W88-05802

**STATE OF THE ENVIRONMENT: 1982.**
Conservation Foundation, Washington, DC.
The Conservation Foundation, Washington, DC. 1982. 463 p.

Descriptors: *Environmental impact statement, *Environmental protection, *Water pollution effects, *Environmental policy, *Environmental effects, Population dynamics, Fate of pollutants, Pollutant identification, Risk assessment, Energy, Erosion, Hazardous wastes, Water pollution control, Water quality, Public policy.

Careful documentation of environmental conditions and trends even more necessary in 1982 than in the past. In the midst of highly charged arguments about new directions, a source of reliable, credible, objective data is crucial. With this report, The Conservation Foundation hopes to provide such a source for 1982. This report describes major resource and environmental problems facing the United States, presents data to show whether the problems are getting better or worse, and discusses institutional changes and options that affect environmental and resource policy. Its intent is to provide an objective descriptive of the state of the U.S. environment. It is inherently more difficult to report on the implications of policy changes than on the effects of changes in air quality or agricultural production. Eventually, changes in environmental policy will result in changes in the physical environment, but it takes time for this to happen, and even more time for these changes to be detected, analyzed, and reported. The physical changes described in this report, for example, reflect policies adopted three or five or ten years ago. The effects of some policy decisions, such as reduced research on toxic substances, may never be detected, even though such decisions may have serious consequences. A very old problem, soil erosion, has grown more acute, even as agricultural production reaches record high levels. Energy efficiency in the U.S. has generally improved, but federal research on both energy conservation and renewable energy resources has been all but eliminated. Nearly 35 million people live in areas that will be unable to meet the air quality standards for protection of human health from ozone by 1987, even if existing automobile emission standards are met. In the past 5 years, two major laws have been passed to deal with hazardous waste disposal. Implementation of both has been slow. Meanwhile, old hazardous waste sites continue to threaten many communities, and much of the waste now being generated is disposed of under environmentally unsafe conditions. Many other sensitive land areas are feeling the pressures of development. Along the Atlantic and Gulf coasts, the nearly 300 barrier islands that serve as the nation's first defense against ocean storms are being urbanized at a pace far greater than mainland areas. Since 1950, barrier island development has proceeded at an estimated rate of 6,000 acres annually, much of it aided by federal funds. (Lantz-PTT)
W88-05803

**STATE OF THE ENVIRONMENT: AN ASSESSMENT AT MID-DECADE.**
Conservation Foundation, Washington, DC.
The Conservation Foundation, Washington, DC. 1984. 586 p.

Descriptors: *Environmental impact statement, *Environmental protection, *Environmental policy, *Water pollution effects, *Environmental effects, Fate of pollutants, Population dynamics, Pollutant identification, Risk assessment, Water pollution control, Water quality, Public policy.

In assessing the state of the environment, The Conservation Foundation found progress, new problems, and institutional stresses in environmental agencies, particularly at the federal level. A new report continues to record progress, attributable to policies implemented five, seven, or ten years ago. The report is divided into two parts. The first three chapters describe environmental conditions and trends. Chapter 1 deals with underlying trends, primarily population growth and economic conditions. Chapter 2 covers environmental contaminants: toxic substances, hazardous waste, air and water pollutants, and overall waste production. Chapter 3 deals primarily with natural resources: water, land (including cropland, forestland, rangeland, wildlands, and critical areas), wildlife, energy, and recreation. The second part of the report analyzes several long-range issues that cut across the traditional categories used to describe environmental problems. Chapter 4 reports on several studies that have tried to identify future environmental problems and discusses the factors that are relevant for establishing priorities among these problems. Chapter 5 explains the methodology used in assessing environmental risks. It focuses primarily on analyzing the risks of chemicals in the environment, but the methodology discussed is also applicable to most of the other environmental risks. Chapter 6 analyzes the extent to which toxic substances move from air to water to land and the policy implications of such movement. The key question is whether a more integrated cross-media approach to pollution control is necessary. Chapter 7 covers water quality and water quantity problems, the interrelationships between them, and issues related to the management of this vital resource. Finally, Chapter 8 explores the intricacies of the relationship between the federal government and the states in implementing environmental policies, and it examines what has been learned about intergovernmental relations and environmental policy from the experience of the past decade. (Lantz-PTT)
W88-05846

**STATE-BY-STATE ENVIRONMENTAL DATA SUMMARIES.**
Conservation Foundation, Washington, DC.
A Supplement to State of the Environment: A View Toward the Nineties. The Conservation Foundation, October 1987. 57 p.

Descriptors: *Data collections, *United States, Environmental protection, Environmental effects, Economic aspects, Water quality, Solid wastes, Hazardous wastes, Waste disposal.

Summaries of selected information on environmental conditions and trends in the 50 United States, are presented. Highlights of each summary are: environmental expenditures, environmental contaminants (air quality, water quality, solid wastes, hazardous waste, nuclear) natural resources (land, water and energy), and protected lands, critical areas and wildlife. Charts are included to show how different states rank according to selected environmental statistics, such as total BOD discharges per capita per year (in lbs), total N discharges per capita per year (in lbs), percentage of population with secondary treatment or better (1984), hazardous waste generation (in lbs), and water consumption per capita per day (in gal, 1980). (Lantz-PTT)
W88-05900

**CORPS' ENVIRONMENTAL EFFECTS OF DREDGING PROGRAMS,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5C.
W88-05909

**CLASS III CULTURAL RESOURCE INVENTORY ON WILLOW CREEK RESERVOIR, LEWIS AND CLARK COUNTY AND PISHKUN RESERVOIR, TETON COUNTY, MONTANA,**
Geological Cultural Management Services, Inc., Butte, MT.
G. Munson.
Available from the National Technical Information Service, Springfield, VA. 22161 as PB88-131487. Price codes: A09 in paper copy; A01 in microfiche. September 30, 1986. 188 p, 3 fig, 7 tab, 76 ref, 4 append. Bureau of Reclamation Contract No. 6-SP-60-01610.

Descriptors: *Social aspects, *Willow Creek Reservoir, *Pishkun Reservoir, *Environmental impact, *Archeology, *Montana, History, Stone rings.

The Class III Cultural Resource Inventory at Willow Creek Reservoir Wildlife Refuge, Lewis and Clark County and Pishkun Reservoir Wildlife Refuge, Teton County, Montana located a total of 42 sites: 27 prehistoric, 13 historic and two sites of undetermined age. Eight of the sites had been located by previous cultural resource inventories. Seventeen loci or isolated finds were recorded: four prehistoric, four historic, and nine rock cairns of undetermined age. Eighteen sites, 12 prehistoric and six historic are considered as potentially eligible for listing on the National Register of Historic Places. Results of the inventory indicate the project area is rich in cultural resources. Stone ring sites are the predominant prehistoric site type and many of these are located so as to be sheltered from the strong westerly winds. This land use pattern for this area of the Rocky Mountain front is distinctive from stone ring sites in northern and northeastern Montana, where stone circle sites are very common but there is generally no consideration of wind protection. The majority of historic sites are related to the construction and maintenance of the Pishkun Reservoir and Willow Creek Reservoir. (Author's abstract)
W88-05911

**RIVERS OF EMPIRE: WATER, ARIDITY, AND THE GROWTH OF THE AMERICAN WEST,**
Brandeis Univ., Waltham, MA. American Environmental Studies.
For primary bibliographic entry see Field 6D.
W88-05916

## 7. RESOURCES DATA

### 7A. Network Design

**DETERMINING THE LIKELIHOOD OF OBTAINING A RELIABLE MODEL,**
Texas Univ. at Dallas, Richardson. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5E.
W88-05169

**RELATION OF LENGTH AND SEX TO SELENIUM CONCENTRATIONS IN MOSQUITOFISH,**
National Fisheries Contaminant Research Center, Dixon, CA. Field Research Station-Dixon.
For primary bibliographic entry see Field 5B.
W88-05197

**COMPARING THREE SAMPLING DESIGNS FOR MONITORING COLIFORMS IN SMALL COMMUNITY WATER SYSTEMS,**
Dartmouth Medical School, Hanover, NH.
For primary bibliographic entry see Field 5F.
W88-05327

**CALIBRATING WATER DISTRIBUTION NETWORK MODELS,**
Visvesvaraya Regional Coll. of Engineering, Nagpur (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W88-05514

**SOFTWARE TO MATCH DISTRIBUTION SYSTEM'S NEEDS,**
Greeley and Hansen, Chicago, IL.
F. M. Maisch, R. M. Schoenborn, and P. Pantumsinchai.
Water Engineering and Management WENMD2, Vol. 134, No. 10, p 20-22, October 1987. 1 fig, 2 tab, 1 ref.

Descriptors: *Reviews, *Computer programs, *Pipe flow, *Water distribution, Utilities, Systems analysis, Costs, Algorithms, Steady state analysis, Head loss, Simulation analysis, Hydraulic models, Digital computers, Network design.

Thirteen computer programs available for water distribution system analysis are surveyed to help utility and engineering firms decide which is best for conditions facing them. The programs address such water distribution problems as steady-state analysis, extended-time-period simulation, and/or transient analysis. The software is evaluated according to input information, hydraulic and numerical algorithms, output information, hardware requirements, and program costs. Ten of the programs use menu-driven input and edit programs, which help novice users but become cumbersome with increasing user familiarity; the other programs have a free-format style with which data can be entered more easily. Hydraulic algorithms include equations used for pipe friction loss and fitting loss computations; numerical algorithms include the numerical methods programs use to solve the hydraulic equations. All programs have a standard output display of pipe information that includes identification and flow and head losses for each pipe, and most have graphic displays of the pipe systems and results. Output reports can be rearranged with an edit program or by retyping specific information into a word processor. Four of the programs operate on both microcomputers and mainframes, 1 on mainframes only, and the rest on micros only. Program costs for micros range from $225 to $5000; with some, graphics capability is an extra-cost option. For steady-state analysis, MICRO HARDY CROSS ($350) and UKPIPE ($225 for the basic program) offer the most capability; extended-time-period simulation and transient analysis are available at higher cost. (Shidler-PTT)
W88-05554

**ANALYSIS OF STATISTICAL MONITORING NETWORK DESIGN,**
Washington Univ., Seattle. Dept. of Civil Engineering.
M. C. MacKenzie, R. N. Palmer, and S. P. Millard.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 5, p 599-615, September, 1987. 7 tab, 18 ref, 1 append. EPRI Project No. RP1729-1.

Descriptors: *Statistical models, *Monitoring, *Networks, *Optimization, *Water pollution effects, Model studies, Cost analysis, Powerplants, Nuclear powerplants, Sensitivity analysis, Algorithms, Case studies, Water quality management, Analysis of variance.

The need to detect anthropogenic impacts in the natural environment has increased interest in the design of cost-effective environmental monitoring networks, and a variety of statistical models have been proposed for this purpose. This paper examines four statistical models, with varying degrees of complexity, used to represent the underlying characteristics of potential impacts. The models are incorporated into an optimization procedure used to select cost-effective designs. Aquatic monitoring data from a nuclear power plant are used to test the robustness of the statistical models, analyze their sensitivity to input parameters, and determine the circumstances that require the use of more complex statistical models to design effective monitoring programs. (Author's abstract)
W88-05636

**IMPORTANCE OF DESIGN QUALITY CONTROL TO A NATIONAL MONITORING PROGRAM,**
Inland Waters Directorate, Ottawa (Ontario).
R. E. Kwiatkowski.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 79-98, 13 fig, 2 tab, 19 ref.

Descriptors: *Statistics, *Water quality control, *Monitoring, *Management planning, *Lake Ontario, Water quality management, Data collections, Data interpretation, Network design, Statistical methods.

Water quality monitoring within Canada has been carried out by the Water Quality Branch, Department of the Environment, since 1970. Recent analyses of national (coast to coast) data for a variety of water quality parameters have identified an inherent difficulty with the interpretability of the data sets stored on NAQUADAT (Canada's National Water Quality Data File). A lacustrine system (Lake Ontario) is used as a case example of this difficulty, described as network design assurance. The importance of network design assurance, both spatially and temporally, to regional and national data sets, is discussed, and a possible solution areal weighting, is presented. Comments on the design of lotic networks under the newly implemented Water Quality Federal-Provincial Agreements are discussed in relation to this difficulty, identifying Canada's present attempt to produce data sets capable of generating statistically and ecologically valid national reports. (See also W88-05862) (Author's abstract)
W88-05869

**RANDOMIZED SIMILARITY ANALYSIS OF MULTISPECIES LABORATORY AND FIELD STUDIES,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Statistics.
For primary bibliographic entry see Field 7C.
W88-05881

**ASSOCIATION OF CHLOROPHYLL A WITH PHYSICAL AND CHEMICAL FACTORS IN LAKE ONTARIO, 1967-1981,**
National Water Research Inst., Burlington (Ontario).
A. H. El-Shaarawi, J. R. Elliott, R. E. Kwiatkowski, and D. R. Peirson.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 273-291, 2 fig, 7 tab, 23 ref.

Descriptors: *Statistics, *Water quality, *Eutrophication, *Lake Ontario, *Chlorophyll a, Biomass, Mathematical studies, Phytoplankton, Organic carbon, Nutrients, Nitrogen, Thermocline, Seasonal variation, Diatoms, Turbidity.

Concerned about the deterioration of the water quality of the lower Great Lakes due to eutrophication, the governments of Canada and the United States signed the 1972 Canada-United States Great

Lakes Water Quality Agreement (renewed in 1978). Though whole lake water quality sampling of Lake Ontario has occurred since 1967, a surveillance program specifically addressing the requirements of the Agreements was initiated in 1974. One of the objectives of the surveillance program was to describe lake conditions on a spatial and temporal basis. Due to the fact that increased biomass is an expected effect of increased nutrient loadings, it was concluded that the cumulative progress of eutrophication could be described by the long-term periodic measurement of phytoplankton standing stocks. Two methods were readily available for measurement of phytoplankton biomass. Direct enumeration and cell volume measurement with subsequent biomass calculation, or indirectly through chlorophyll a measurement. In Lake Ontario, phytoplankton biomass maxima, represented by chlorophyll a concentration, were consistently found in the spring and fall, with minima in the summer. It is interesting to note that the other biomass indicators, integrated particulate organic carbon and integrated total particulate nitrogen (measure of total biomass) proved to be the most influential variables in explaining chlorophyll a (measure of phytoplankton) variability. Several explanations exist for why the relationships between chlorophyll a and the other physico-chemical variables decrease during the summer stratified period, and include: a decrease in nutrient concentration, thermocline, diatom concentration, turbidity. (See also W88-05862) (Lantz-PTT)
W88-05882

**HIGH FREQUENCY WATER QUALITY MONITORING OF A COASTAL STREAM,**
Inland Waters Directorate, Vancouver (British Columbia). Pacific and Yukon Region.
For primary bibliographic entry see Field 7B.
W88-05894

**DESIGN OF A COST EFFECTIVE MICROCOMPUTER-BASED DATA ACQUISITION SYSTEM,**
Bradley Univ., Peoria, IL. Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 7B.
W88-05895

## 7B. Data Acquisition

**UNDERSTANDING GROUNDWATER MONITORING,**
D. L. Russell.
Chemical Engineering CHEEA3, Vol. 94, No. 15, p 101-105, October 26, 1987. 6 fig.

Descriptors: *Groundwater monitoring, *Electromagnetic surveys, *Seismic profiles, *Monitoring wells, Wells, Field tests, Groundwater.

Groundwater monitoring techniques are explained and reviewed. The techniques include: ground-penetrating radar, electro-magnetic and electrical surveys, seismic profiling, drilled-well techniques, and groundwater monitoring wells. Sampling and analytical programs are discussed. There are at least three separate series of analyses conducted on groundwater: (1) for pollutants covered by the Resource Conservation and Recovery Act; (2) for EPA Priority Pollutants; and (3) for Drinking Water Standards compliance. Political and technical factors must also be considered. (Alexander-PTT)
W88-05130

**EFFECTS OF NONLEVEL PLACEMENT ON ACCURACY OF LONG-THROATED FLUMES,**
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
J. A. Replogle, B. J. Fry, and A. J. Clemmens.
Journal of Irrigation and Drainage Engineering (ASCE) JIDEDH, Vol. 113, No. 4, p 585-594, November 1987. 6 fig, 1 tab, 7 ref.

Descriptors: *Discharge measurement, *Gaging, *Flumes, *Model studies, *Slope, *Hydrodynamics, Laboratory tests, Calibrations, Mathematical equations.

Tests were conducted to study the effects of nonlevel placement or contruction on the calibration of long-throated flumes. These flumes have previously been mathematically modeled to provide accurate (+ or - 2%) calibrations for a variety of cross-sectional shapes. While cross-slope can be handled successfully by the modeling procedure, no assured procedure was apparent for longitudinal slope corrections. Laboratory tests were directed to determining errors that a user might experience if a flume crest were placed at various positive and negative longitudinal slopes. The magnitude of systematic errors are shown for portable flumes with either a sidewall gage or a translocated stilling well, and for permanently placed flumes. Correction procedures are suggested. Using a sidewall gage without careful leveling equipment is not recommended. A translocated stilling well is strongly recommended for portable flumes. (Author's abstract)
W88-05144

**METROPOLITAN WATER SUPPLY SYSTEM OPTIMIZATION FOR WATER ALLOCATION DURING DROUGHT IN SALT LAKE COUNTY,**
Utah State Univ., Logan. Coll. of Engineering.
For primary bibliographic entry see Field 6D.
W88-05219

**DOPPLER EFFECT TIED TO FLOW RATE,**
Polysonics, Inc., Houston, TX.
R. Yost.
Water Engineering and Management WENMD2, Vol. 134, No. 3, p 30-31, March 1987.

Descriptors: *Doppler effect, *Flow rates, *Flow measurement, *Doppler flowmeters, *Measuring instruments, *Path of pollutants, Ultrasonics, Pollutants, Pipe flow, Pipes, Flow, Water transport, Wastewater, Suspended solids.

Flowmeters designed around the Doppler principle are widely applied in industry to measure velocity of sludges, slurries, sanitary and industrial wastewaters, process chemical flows and other liquids containing suspended particles. In the absence of sufficient solids, the equivalent in air or gas bubbles will produce accurate readings. The physical principles of the Doppler effect are reviewed. Conditions under which Doppler measurement is effective include: (1)liquid flow, (2) a full pipe, (3) pipe material that permits ultrasonic signal penetration, (4) presence of sonic reflectors such as suspended solids, gas bubbles, flow disturbances, or fluid discontinuities that are representative of the fluid flow, (5) well-developed flow profile, and (6) flow velocity above a specified minimum (usually greater than 0.5 feet/second). Factors influencing the performance of Doppler meters when used in virtually clean liquids were detailed. Advantages of Doppler flowmeters include: (1) non-intrusive flow measurement, (2) easy installation and operation, (3) no release of toxic chemicals, bacteria, or other pollutants carried in the pipes during measurement, (4) no moving parts to wear out or fail, (5) price range of 1800 to 5000 dollars, (6) uncomplicated reinstallation and operating requirements which facilitate personnel training, and (7) accurate measurements under a variety of specific conditions. Sources of error in Doppler measurements, including responses of different pipe materials, are discussed. (Wood-PTT)
W88-05277

**SEPARATION OF DINOFLAGELLATE CYSTS INTO DENSITY GRADIENTS (SEPARACION DE QUISTES DE DINOFLAGELADOS EN GRADIENTE DE DENSIDAD),**
Instituto Espanol de Oceanographia, La Coruna (Spain). Centro Costero del La Coruna.
J. Blanco.
Boletin del Instituto Espanol de Oceanografia, Vol. 3, No. 3, p 81-84, December 1986. 1 tab, 5 ref.

Descriptors: *Centrifugation, *Separation techniques, *Dinoflagellates, *Data acquisition, Sediments, Concentration techniques, Density, Populations.

A technique based on discontinuous density gradient centrifugation is described that is useful for concentrating dinoflagellate cysts from the sediment. This technique is also used for splitting cyst populations. (Author's abstract)
W88-05290

**EFFICIENCY OF LUDOX-TM IN THE SEPARATION OF BENTHIC MICROALGAE FROM SEDIMENT (EFICACIA DEL LUDOX-TM EN LA SEPARACION DE MICROALGAS BENTONICAS DEL SEDIMENTO),**
Instituto Espanol de Oceanographia, La Coruna (Spain). Centro Costero del La Coruna.
M. Varela.
Boletin del Instituto Espanol de Oceanografia, Vol. 3, No. 3, p 85-88, December 1986. 1 fig, 12 ref. Programa Cooperativo Hispano-norteamericano Grant 0020.

Descriptors: *Colloids, *Separation techniques, *Microalgae, *Data acquisition, Sediments, Silica, Algae, Specific gravity, Density, Benthic flora, Benthos.

The efficiency of colloidal silica Ludox-TM for separating benthic microalgae from their substrate was tested using natural sediments. The distribution of cells in the Ludox layers varied depending on cell specific gravity. Thus, particular layers are not necessarily representative of the total microalgal community. In some layers where the specific gravity of detritus particles corresponds to microalgae, microscopic examination is difficult and the counting error is high. (Author's abstract)
W88-05291

**DEVELOPING AUTOMATED MULTISPECIES BIOSENSING FOR CONTAMINANT DETECTION,**
Tennessee Technological Univ., Cookeville. Center for the Management, Utilization and Protection of Water Resources.
For primary bibliographic entry see Field 5A.
W88-05298

**SOIL HEAT FLUX IN PERMAFROST: CHARACTERISTICS AND ACCURACY OF MEASUREMENT,**
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2C.
W88-05310

**ORGANIC CONTAMINATION OF GROUNDWATER: A LEARNING EXPERIENCE,**
Hawaii Univ., Honolulu. Water Resources Research Center.
L. S. Lau, and J. F. Mink.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 8, p 37-42, August 1987. 1 fig, 3 tab, 19 ref.

Descriptors: *Water quality control, *Water pollution sources, *Groundwater pollution, *Wells, Oil spills, Oahu, Hawaii, Pesticides, Ethylene dibromide, Dibromochloropropane, Agricultural chemicals, Aquifers, Monitoring, Legislation, Standards, Water quality standards, Land management, Agricultural chemicals, Risks, Land use.

Publicity on discovery of high levels of dibromochloropropane (DBCP) and ethylene dibromide in groundwater of Oahu, Hawaii, in 1977 was the beginning of a water monitoring program at several sites in the pineapple growing region. In 1983 several municipal wells at Mililani and Waipahu were closed because DBCP levels were excessive. The affected Pearl Harbor aquifer, with a sustainable yield of 225 mgd, was fully allocated in 1980. The closed wells had provided 13 mgd, accounting for a significant loss of water supply. Several strategies were developed to cope with pesticide contamination; legislative policies, administrative rule-making, communication, and technological abatement. The state legislature mandated closer reporting on the sale and distribution of pesticides and took other steps to strengthen the authority of state environmental officials. Technical strategies include (1) monitoring water sources to show the

extent of contamination, (2) developing a data base, (3) treating contaminated water with granular activated carbon at a total cost of $8 million, (4) developing water well technology, and (5) conducting research. The importance of establishing water quality standards, risk assessment, groundwater monitoring, confirming laboratory reports before taking action, cooperating with the news media, and considering land use management as a protective means is stressed. (Cassar-PTT)
W88-05336

**SPECTROPHOTOMETRIC DETERMINATION OF TOTAL CYANIDE IN WASTE WATERS IN A FLOW-INJECTION SYSTEM WITH GAS-DIFFUSION SEPARATION AND PRECONCENTRATION,**
Academia Sinica, Shenyang (China). Inst. of Forestry and Soil Science.
For primary bibliographic entry see Field 5A.
W88-05357

**INDIRECT DETERMINATION OF FLUORIDE IN WATERS WITH LANTHANUM ALIZARIN COMPLEXONE AND INDUCTIVELY COUPLED PLASMA EMISSION SPECTROMETRY,**
National Research Inst. for Pollution and Resources, Yatabe (Japan).
A. Miyazaki, and K. Bansho.
Analytica Chimica Acta ACACAM, Vol. 198, p 297-302, July 15, 1987. 2 fig, 4 tab, 16 ref.

Descriptors: *Spectrometry, *Water analysis, *Fluoride, *Lanthanum alizarin complexone, Drinking water, Seawater.

Fluoride is determined indirectly by measurement of the La II 333.75-nm line in the lanthanum/alizarin complexone/fluoride complex/ The ternary complex is extracted into hexanol containing N,N-diethylaniline, and the extract is introduced directly into the plasma. Related to water samples, the detection limit is 0.59 ng/ml fluoride, calibration is linear up to 1.2 microgram/ml and the relative standard deviation for 0.04 microgram/ml is 2.6%. Alkali, alkali earth elements and most anions do not interfere. The method is applied in the analysis of river water, coastal seawater and drinking water (Author's abstract)
W88-05358

**SPECTROPHOTOMETRIC FIELD MONITOR FOR WATER QUALITY PARAMETERS: THE DETERMINATION OF PHOSPHATE.**
Hull Univ. (England). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W88-05377

**NOVEL ADSORBENT FOR THE DETERMINATION OF THE TOXIC FRACTION OF COPPER IN NATURAL WATERS,**
Commonwealth Scientific and Industrial Research Organization, Lucas Heights (Australia).Div. of Energy Chemistry.
For primary bibliographic entry see Field 5A.
W88-05378

**DETERMINATION OF COPPER IN NATURAL WATERS BY ATOM-TRAPPING ATOMIC ABSORPTION SPECTROMETRY AFTER LIQUID/LIQUID EXTRACTION,**
Sheffield Univ. (England). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W88-05379

**SELECTIVE CHLORINE DETERMINATION BY GAS-DIFFUSION FLOW INJECTION ANALYSIS WITH CHEMILUMINESCENT DETECTION,**
Miami Univ., Oxford, OH. Dept. of Chemistry.
For primary bibliographic entry see Field 5F.
W88-05390

**SULFURIC ACID CLEANUP AND KOH-ETHANOL TREATMENT FOR CONFIRMATION OF ORGANOCHLORINE PESTICIDES AND POLYCHLORINATED BIPHENYLS: APPLICATION TO WASTEWATER SAMPLES,**
University Coll. of Castellon (Spain). Environmental Lab.
For primary bibliographic entry see Field 5A.
W88-05391

**CAPILLARY COLUMN GAS CHROMATOGRAPHIC DETERMINATION OF TRACE RESIDUES OF THE HERBICIDE CHLORSULFURON IN AGRICULTURAL RUNOFF WATER,**
Alberta Environmental Centre, Vegreville.
For primary bibliographic entry see Field 5A.
W88-05392

**THERMOSPRAY LC/MS/MS ANALYSIS OF WASTEWATER FOR DISPERSE AZO DYES,**
Environmental Monitoring Systems Lab., Las Vegas, NV.
For primary bibliographic entry see Field 5D.
W88-05394

**CHANNEL DISCHARGE MEASUREMENT BY THERMODILUTION,**
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
R. J. Wittler, S. R. Abt, and T. G. Sanders.
Water Resources Bulletin WARBAQ, Vol. 23, No. 6, p 1109-1115, December 1987. 4 fig, 4 tab, 10 ref.

Descriptors: *Thermodilution, *Channel flow, *Flow measurement, *Open channels, Flow discharge, Discharge measurement, Flowmeters, Open Channels, Flow, Feasibility studies, Froude number, Mathematical equations, Tracers, Design criteria.

The feasibility of applying thermodilution technology to discharge measurements in small open channels was determined. A series of tests were performed in which the time-temperature dilution curves were recorded and analyzed. The independent variables included the channel discharge, the injectate drop height, the volume of tracer, and the mixing distance. Flows ranged from 0.67 cfs to 2.45 cfs with Froude numbers less than 0.30. The results indicated that the thermodilution technique is a feasible method for discharge measurement. It was determined that a heat content, I*, of 40 degrees C-l provides a design criteria in which the mixing distance was related to the flow depth and discharge in a rectangular channel. An empirical expression was derived to determine the approximate mixing distance as a function of the flow depth. (Author's abstract)
W88-05414

**PINPOINTING NONPOINT POLLUTION,**
Tennessee Valley Authority, Chattanooga. Mapping Services Branch.
For primary bibliographic entry see Field 5B.
W88-05473

**VARIABILITY OF BED LOAD MEASUREMENT,**
Colorado State Univ., Fort Collins. Dept. of Earth Resources.
J. Pitlick.
Water Resources Research WRERAO, Vol. 24, No. 1, p 173-177, January 1988. 4 fig, 12 ref. U.S. Army Research Office Grant DAAG29-85-K-0108.

Descriptors: *Bed load, *Bed-load transport, *Helley-Smith sampler, *Measuring instruments, *Comparison studies, *Channels, Sampling, Sampling efficiency, Field tests, Sand, Sediment transport, Monitoring.

The sampling efficiencies of two slightly different Helley-Smith bed load samplers were compared under carefully controlled field conditions. The samplers were identical in all respects except for the thickness of the metal used in their construction. The test results indicate that for coarse-grained sand bed load, the sampler with a wall thickness of 1.5 mm has a sediment trap efficiency that can be as much as two times that of the sampler with walls that are 6.3 mm thick. In a separate test, bed load transport was monitored at a single channel cross section during a 10-hour period of steady discharge. At individual sampling stations, measurement values ranged from nearly 0 to 3 times the mean. Composite bed load transport rates for full traverses of the channel width varied by a factor of 2. (Author's abstract)
W88-05542

**MAKING CHLORINATION TRUSTWORTHY,**
Fischer and Porter, Co., Warminster, PA.
For primary bibliographic entry see Field 5F.
W88-05566

**NEW DEVICE FOR SAMPLING WATERS IN SHALLOW ECOSYSTEMS,**
Cadiz Univ. (Spain). Dept. de Quimica-Fisica.
A. Gomez-Parra, J. M. Forja, and D. Cantero.
Water Research WATRAG, Vol. 21, No. 11, p 1437-1443, November 1987. 7 fig, 2 tab, 7 ref.

Descriptors: *Water sampling, *Measuring instruments, *Data acquisition, *Sampling, *Shallow ecosystems, Aspiration, Water temperature, Dissolved gases, Dissolved oxygen, Water properties, Chemical properties, Physical properties.

A set of equipment was designed to take water samples by aspiration at varying depths in shallow ecosystems. The depths sampled can be selected within a range of accuracy of 1 cm. The equipment is portable and can be handled from a boat or from the shore, at points up to 20 meters away from the sampling location. Excellent results were obtained in sample collection for the determination of nutrient content, pH, alkalinity, salinity, suspended solids, and other physical and chemical parameters. The equipment is better than that used traditionally to obtain samples for trace metal analyses since the samples only come in contact with non-metallic materials such as glass and polyethylene. The accuracy of temperature and dissolved gas content of samples obtained using the device was determined. There was no serious loss of gas from the samples as long as they aspirated under a reduced pressure $<400$ mm Hg. This system enables the collection at a rate of 10.4 l/hr when the apparatus is placed about 2 or 3 meters above the surface of the ecosystem under investigation. The error which occurs in the temperature reading is a function of the differences in temperature between the mass of water sampled and the area surrounding the intake tubes. For differences of around 1 deg C, the error is $<0.1$ deg C. Some modifications of the equipment are also suggested in order to simplify the operations necessary to take samples for dissolved gas measurement. Also proposed is a system of on-line filtration useful for quantitative phytoplankton or suspended solid content determinations in the samples. (Wood-PTT)
W88-05603

**DETERMINATION OF PHOSPHORUS IN NATURAL WATER USING HYDRIDE GENERATION AND GAS CHROMATOGRAPHY,**
National Research Inst. for Metals, Tokyo (Japan).
For primary bibliographic entry see Field 2K.
W88-05608

**CLASSIFICATION OF SUSPENDED PARTICLES IN DEPOSITION SAMPLES AND RUN-OFF WATER SAMPLES FROM A LIMESTONE CATHEDRAL,**
Antwerp Univ., Wilrijk (Belgium). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W88-05635

**EVALUATION OF VERTICAL MOTION SENSORS FOR POTENTIAL APPLICATION TO HEAVE CORRECTION IN CORPS HYDROGRAPHIC SURVEYS,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
G. C. Downing, and T. L. Fagerburg.

Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report No. HL-87-10, October 1987. Final Report. 81 p, 32 fig, 26 ref, append.

Descriptors: *Instrumentation, *Montion sensors, *Hydrography, *Waves, *Research vessels, Water level, Costs, Doppler effect, Lasers, Boats, Stress, Displacement, Surveys, Sonar, Performance evaluation, Hydraulic structures, Hydraulic similitude.

Techniques and equipment that can help surveyors obtain the best practical vertical reference for hydrographic surveys in the face of adverse tide, river stage, and wave conditions, are described. Some specific measurement techniques for monitoring vertical references for hydrographic surveys under given field conditions are addressed. Depth transducer draft, boat flotation plane, and shore references are discussed in Part I. Dynamic vertical motions of the boat hull are discussed in Part II. Vertical displacement measurement equipment using automatic electrooptical tracking systems, video-type optical tracking systems, laser leveling systems, and satellites is assessed and found to have potential for future consideration and application in improving survey accuracy. Evaluation of a heave compensation unit based on a pendulum-stabilized accelerometer platform (HIPPY 120) was attempted on a survey boat in the US Army Engineer District, Philadelphia. Protracted difficulties with the system prevented a quantitative evaluation. After the first installation was found to be unsuccessful, the HIPPY 120 was transferred to a survey boat in the US Army Engineer District, New York. The results, however, were much the same as in the first installation. These results lead to the conclusion that for this system to be successfully used during actual survey operations, there must be a higher-than-average level of technical skill among the personnel on the survey boat. An effort was made to validate Doppler equipment for use in heave compensation. Measurements were made at dockside and also during actual survey operations, there must be a higher-than-average level of technical skill among the personnel on the survey boat. An effort was made to validate Doppler equipment for use in heave compensation. Measurements were made at dockside and also during actual survey operations using a modified Doppler navigator. The tests conducted indicated that the measuring principle was sound but also that much additional development was needed. Funding constraints and the entry on the market of a commercial Doppler heave compensation unit resulted in the decision to discontinue development of the Government-sponsored Doppler heave compensation unit. (Author's abstract)
W88-05708

**PARADISE STEAM ELECTRIC PLANT, ASH-POND TOXICITY BIOMONITORING STUDY - OCTOBER 1986,**
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
For primary bibliographic entry see Field 5G.
W88-05710

**TOMOGRAPHIC INVESTIGATIONS AT LANDFILL 4, HILL AIR FORCE BASE, LAYTON, UTAH,**
Weston Geophysical Corp., Westborough, MA.
G. M. Jones, and V. J. Murphy.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A181 289. Price codes: A03 in paper copy, A01 in microfiche. Report No. AFGL-TR-87-0055. Scientific Report No. 1, April 23, 1987. 36 p, 20 fig, 1 ref. SBIR Contract No. F19628-84-C-0130.

Descriptors: *Tomography, *Hill Air Force Base, *Utah, *Data acquisition, *Soil water, *Landfills, Flow velocity, Groundwater movement, Slurries, Boreholes, Seismic properties, Geophysics.

In support of soil classification objectives related to an ongoing study of non-linear soil response, tomographic techniques were developed and tested using seismic data. The data were collected at three locations at Landfill 4, Hill AFB, Utah. The site is a landfill waste site which had been isolated from the prevailing groundwater flow by a slurry trench. The objective of this study was to identify the effectiveness of geophysical techniques for seismic velocity measurements and tomographic/imaging analyses. Seismic data were collected between pairs of 50 ft. deep boreholes on either side of the slurry trench. First break picks were analyzed using an iterative back-projection tomographic technique utilizing curved rays. Initial processing revealed that smearing of velocity anomalies between the boreholes occurred because of non-optimum placement of shots and receivers. Adding reasonable constraints to the inversion, however, showed a low-velocity region, terminating between 35 and 40 ft., at the trench location. Diffracted arrivals travelling around the base of the low-velocity region further constrained its depth. Other minor low-velocity zones, possibly indicating layers with increased silt content, were also indicated by the inversion model. This study showed that cross-borehole tomography can be a useful tool in delineating velocity anomalies roughly perpendicular to paths between the boreholes, but that velocity anomalies parallel to the boreholes will be smeared unless additional constraints are imposed. A modification to the data acquisition technique to help overcome this problem would be to use additional high-energy shot-points on the surface between the boreholes. (Author's abstract)
W88-05715

**INTERNATIONAL SYMPOSIUM ON MICROWAVE SIGNATURES AND REMOTE SENSING,**
Office of Naval Research, London (England).
J. Williams.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A181 334. Price codes: A02 in paper copy, A01 in microfiche. Office of Naval Research, London, Report No. 7-010-C, May 28, 1987. 10 p.

Descriptors: *Information exchange, *Remote sensing, *Microwaves, *Symposium, Radiation, Vegetation, Ice, Snow, Data acquisition, Radar, Model studies.

Ninety participants from 16 countries attended the Fourth International Symposium on Microwave Signatures in Remote Sensing held at the Chalmers University of Technology at Gothenburg, Sweden, from 19 through 22 January 1987. Discussions covered signatures from snow and ice, solid ground, ocean surfaces, and vegetation, and considered systems and radar altimetry, interactions and modeling, and new methods. (Lantz-PTT)
W88-05722

**MONITORING BIOFOULING,**
Krakow Technical Univ. (Poland).
W. Wojcik, and M. Wojcik.
IN: Proceedings of the 1986 International Symposium on Biofouled Aquifers: Prevention and Restoration, 1987. p 109-119, 6 fig, 1 tab, 10 ref.

Descriptors: *Monitoring, *Biofouling, *Water quality control, *Groundwater quality, Wells, Microbiological studies, Physical properties, Chemical analysis, Hydraulic properties, Bacteria.

Monitoring of biofouling in water wells can be done by monitoring both presence of the bacteria and the effects of their activity. Different groups of methodologies can be utilized for this purpose, including: microbiological surveys; biochemical, physico-chemical and optical analyses; and hydraulic testing. Some methods are quite simple and can be performed by inexperienced operators of a small water supply system, while others require professionals and sophisticated testing equipment. Proper samples should be taken both from the water and the deposit material in order to monitor the floating as well as attached bacteria. (See also W88-05724) (Author's abstract)
W88-05735

**STORAGE AND PRESERVATION OF ENVIRONMENTAL SAMPLES,**
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 5A.
W88-05749

**REMOTE SENSING: METHODS AND APPLICATIONS,**
MRJ, Inc., Oakton, VA.
R. M. Hord.
John Wiley and Sons, New York, NY. 1986. 362 p.

Descriptors: *Remote sensing, *Data acquisition, *Data interpretation, Radar, Thermal scanners, Mapping, Mathematical analysis, Algorithms, Geology, Meteorology, Agriculture, Multispectral scanners, Vidicon equipment, Oceanography, Satellite technology.

This book examines the state of the art in remote sensing. The material is organized around three broad subjects: sensors, processing and analysis techniques, and applications; and each of these is covered in an extensive chapter. In Chapter 1, the book's emphasis on civilian spaceborne data sources is established, with indepth coverage of radar imaging, coastal zone color scanners, thematic mappers, and return beam vidicon equipment. Chapter 2 brings together algorithms and other methods for converting bits into pictures, extracting features of the patterns in those pictures, and evaluating results. Chapter 3 describes the uses of remote sensing technology in meteorology, geology, agriculture, and oceanography. The Appendix provides a list of pixel values for a window of a Landsat Multispectral Scanner (MSS) image so that the reader can try some processing on real data. (Lantz-PTT)
W88-05780

**REMOTE SENSING AND IMAGE INTERPRETATION,**
Wisconsin Univ.-Madison.
T. M. Lillesand, and R. W. Kiefer.
John Wiley and Sons, New York, NY. 2nd Edition. 1987. 721 p.

Descriptors: *Remote sensing, *Data interpretation, *Data acquisition, Aerial photography, Mapping, Wetlands, Photography, Thermal scanners, Radar, Multispectral scanners, Textbook, Satellite technology.

Remote sensing is presented in a comprehensive textbook of value to engineers, soil scientists, foresters, range managers, geologists, geographers, oceanographers, land planners, meteorologists, archaeologists, water resource managers, biologists or anyone involved in measuring, studying, and managing earth resources. It focuses on remote sensing systems and illustrates their utility in a diverse range of data gathering applications. After presenting the basic physical principles on which remote sensing is based, the first half of this book concentrates on photographic remote sensing techniques. The tools of the photographic trade (cameras, films, and so on) are discussed, and then a general introduction to the airphoto interpretation process is provided. This introduction includes sample applications of airphoto interpretation in specific mapping tasks, such as land use/land cover mapping (including geographic information system design concepts), wetlands mapping, and geologic and soil mapping. Also discussed, in very general terms, is the application of airphoto interpretation to the fields of agriculture, forestry, range management, water resources, urban and regional planning, wildlife ecology, archaeology, and environmental assessment. An entire chapter is devoted to terrain evaluation via airphoto interpretation. The second half of the book deals with the principles of acquiring and interpreting data collected by non-photographic sensors. Thermal scanners, multispectral scanners, and radar systems are described. As with the discussion of photographic techniques, how the images are produced from these systems, and interpreted in various application areas is illustrated. The book concludes with treatment of the subject of digital image processing. (Lantz-PTT)
W88-05781

**GEOLOGICAL INTERPRETATION OF WELL LOGS,**

Rider-French Consulting Ltd., Cambridge (England).
For primary bibliographic entry see Field 7C.
W88-05782

ELECTRICAL CONDUCTIVITY,
Worcester Coll., Oxford (England). Dept. of Geography.
C. R. Fenn.
IN: Glacio-Fluvial Sediment Transfer: An Alpine Perspective. John Wiley and Sons, New York, New York. 1987. p 377-414, 8 fig, 7 tab, 41 ref.

Descriptors: *Conductivity, *Glaciers, *Glaciohydrology, *Geophysics, *Glaciology, *Electrical studies, Hydrologic properties, Physical properties, Snowmelt, Glaciology, Glacial streams, Chemistry, Stream discharge, Water analysis.

Examined are the ways in which electrical conductivity (EC) has been employed in hydroglaciological studies. The first part considers the uses and limitations of EC as a parameter of meltwater quality. The second part reviews results obtained from studies of meltwater conductivity in supraglacial environments. The third part considers the EC characteristics of proglacial streams, focusing on the nature and significance of spatial and temporal variability in reported results, and on the characteristics of conductivity-discharge relationships. The final part highlights the ways in which EC studies have contributed in the investigation of problems in glacier hydrochemistry and glacier hydrology. (See also W88-05784) (Author's abstract)
W88-05797

ESTIMATION OF SURFACE WATER RESOURCES,
For primary bibliographic entry see Field 6A.
W88-05833

MODELING RIVER ACIDITY - A TRANSFER FUNCTION APPROACH,
Norsk Regnesentral, Oslo.
For primary bibliographic entry see Field 7C.
W88-05866

DETERMINATION OF WATER QUALITY ZONATION IN LAKE ONTARIO USING MULTIVARIATE TECHNIQUES,
Inland Waters Directorate, Burlington (Ontario). Water Quality Branch.
For primary bibliographic entry see Field 7C.
W88-05870

EXTENSION OF WATER QUALITY DATA BASES IN PLANNING FOR WATER TREATMENT,
California Univ., Davis.
G. T. Orlob, and N. Marjanovic.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 173-182, 5 fig, 4 tab, 1 ref.

Descriptors: *Statistics, *Water quality, *Management planning, *Water treatment, *Statistical analysis, Data acquisition, Case studies, Statistical methods, Time series analysis.

Design of water treatment facilities requires estimation of extreme values of critical water quality parameters. When water quality data for the source are sparse or non-existent a sufficient record for statistical analysis must be constructed from fragmentary records at nearby locations. A procedure is described for construction of the necessary record and derivation of a design target vector of water quality. The principal steps in the procedure are as follows: (1) Spatial correlation between stations with partial records; (2) Time series analysis of selected records; (3) Frequency analysis; (4) Selection of design frequency and duration of exceedence; (5) Correlation analysis between multiple parameters; (6) Translation of quality characteristics to design location; and (7) Formation of a design target vector. The North Bay Aqueduct of the California State Water Project is used as a case study. (See also W88-05862) (Lantz-PTT)
W88-05874

SOME APPLICATIONS OF LINEAR MODELS FOR ANALYSIS OF CONTAMINANTS IN AQUATIC BIOTA,
University of Western Ontario, London.
For primary bibliographic entry see Field 7C.
W88-05879

COMPARATIVE STUDY OF THE SAMPLING PROPERTIES OF FOUR SIMILARITY INDICES,
H. W. Khoo, and T. M. Lim.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 246-260, 4 fig, 3 tab, 13 ref.

Descriptors: *Statistics, *Data acquisition, *Data interpretation, *Statistical analysis, Similarity, Computers, Simulation analysis.

In terms of sampling properties, a reliable similarity index would be one with low tendency to give values that deviate from the true similarity values and with small dispersion of index values for repeated measurements of the same community similarity. The magnitude of bias and dispersion of a sample of good similarity measures should not vary with factors such as sample size and the number of species involved in the community comparison. Several workers have evaluated the practicality of different similarity indices in biological work but, few studies really looked into the sampling properties of the affinity measures. To determine how a similarity index behaves with different sampling parameters in the field is quite tedious and difficult since nature is almost always too complex to allow for controlled sampling experiments. But with the aid of a computer, it is possible to simulate artificial communities on which proper and repeatable sampling trials can be carried out and the sampling behaviors of the indices studied. Using computer generated samples taken from simulated communities, the sampling responses of four commonly used similarity indices was investigated. All these indices have an upper limit of 1 (identical resemblance) and a lower limit of 0 (no resemblance). The four chosen indices are: Gower's general coefficient of similarity, Bray-Curtis' index, Morisita's index, and the Euclidean distance index. The sampling responses of these four similarity measures were studied with respect to various sample sizes, quadrate sizes and the number of species attributes. None of the indices examined was absolutely superior. In terms of accuracy with respect to sample size, Morisita's index had the least bias at small sample size; in terms of precision and sample size, the Euclidean index was most precise, and in terms of precision in relation to species number, Bray-Curtis' index was the best. (Lantz-PTT)
W88-05880

RANDOMIZED SIMILARITY ANALYSIS OF MULTISPECIES LABORATORY AND FIELD STUDIES,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Statistics.
For primary bibliographic entry see Field 7C.
W88-05881

SYSTEMS APPROACH TO COMPUTERIZING DATA ACQUISITION,
T. R. Clune.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 418-432, 11 ref.

Descriptors: *Computers, *Hardware, *Data acquisition, Network systems, Automation, Computer programs.

The problems of computerizing an established laboratory procedure are legion and highly specific. There are three major sources of failure in automation projects. The first stems from underestimating the amount of digital information necessary to reproduce an analog experiment. The second might be characterized as the belief that putting an A/D board into a microcomputer creates a data acquisition instrument. The third difficulty stems from the desire to include unnecessary and highly complex refinements in the system. For example, real-time display and analysis of data almost always interferes with the ability to acquire the data itself. Similarly, the desire to use the data acquisition computer for word processing or departmental bookkeeping as foreground tasks while the system is collecting data can jeopardize the data acquisition process. Even in successful computerization projects, these problems tend to be dealt with on an orderly manner, according to specification. It is necessary to consider a great deal of detail in designing a computerized installation. The detail is considered from the perspective of how it affects the overall performance of the acquisition system. (See also W88-05862) (Lantz-PTT)
W88-05893

HIGH FREQUENCY WATER QUALITY MONITORING OF A COASTAL STREAM,
Inland Waters Directorate, Vancouver (British Columbia). Pacific and Yukon Region.
N. E. Dalley.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 433-442, 6 fig, 4 ref.

Descriptors: *Water quality, *Monitoring, *Coastal waters, Streams, Hydrogen ion concentration, Flow rate, Computer programs, Graphic analysis, Discharge frequency.

High frequency monitoring of a number of water quality indicators was carried out for a one year period in a Pacific coastal stream. A computer program was written to facilitate presentation and preliminary analysis of the data collected. Application of the program to these data demonstrated a number of interesting short term variations in the indicators being monitored. In a stream with highly variable discharge, or seasonally low flow rates, rapid changes in pH and other variables can be expected. This study confirms the conclusion that high frequency monitoring can be an appropriate strategy and concludes that in streams with widely varying discharge, it is the preferred approach. Data acquisition devices should be flexible and adhere to standards in their input and output functions, and should have large data storage capacity and low power consumption. Reliability and downtime are of prime importance. Information on reliability should be obtained from other users prior to purchase if possible. Sensors and electronic recording devices must be chosen with care to ensure the appropriate sensitivity for the application being considered. (See also W88-05862) (Lantz-PTT)
W88-05894

DESIGN OF A COST EFFECTIVE MICROCOMPUTER-BASED DATA ACQUISITION SYSTEM,
Bradley Univ., Peoria, IL. Dept. of Mechanical Engineering.
K. Okamura, and K. Aghai-Tabriz.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 443-459, 7 fig, 10 ref.

Descriptors: *Data acquisition, *Computers, *Design criteria, Costs, Computer programs, Data storage.

The designing of a data acquisition system utilizing a mass produced microcomputer is a very attractive proposition. The high volume production of a general purpose microcomputer makes it quite inexpensive compared to a commercially available

microprocessor-based data acquisition system. The microcomputer system provides the designer with the flexibility and versatility of high level language software while still retaining the capacity of high speed through the use of assembly language programming. It is possible for the designer to customize the data acquisition system to his/her own particular specifications. The design and testing procedure for a data acquisition system using a Commodore 64 computer system are presented. The unique feature of hardware and software of the Commodore 64, which is one of the best selling and lowest cost computers, is utilized to simplify the design. Limitations in using the C-64 as a base unit of data acquisition system include speed and memory capacity. But, in many cases, the C64DAS produces satisfactory results. A software package was developed for data acquisition, display, and transmission. The package consists of two parts: (1) DACQ, for relatively fast acquisition, suitable for obtaining data on a transient phenomenon; and (2) DATALOG, suitable for monitoring and recording slowly changing physical quantities. (See also W88-05862) (Lantz-PTT)
W88-05895

## 7C. Evaluation, Processing and Publication

**EVALUATION OF SOME EMPIRICAL METHODS FOR FLOOD FREQUENCY ANALYSIS, 2. DATA AND COMPUTER PROGRAMS,**
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
D. Jain and, and V. P. Singh.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-139803/AS. Price codes: A06 in paper copy; A01 in microfiche. Contract No. 14-08-0001-G1020. Project No. USGS G1020-06(4). Completion Report, (1987). 101 p.

Descriptors: *Flood frequency analysis, *Model studies, *Computer programs, *Hydrologic data, Data collections, Historical data, Louisiana, Estimation.

This report is the concluding part II in a series of two. In part I nine empirical methods, used to perform flood frequency analysis, were evaluated and compared using historical data from 55 river gaging stations. These data are presented in this part II. A computer-software was developed to analyze the data, and evaluate each method as well as compare different methods of flood frequency analysis. This software is included in this report. (Singh-LA WRRI)
W88-05234

**EVALUATION OF PARAMETER ESTIMATION METHOD FOR FLOOD FREQUENCY ANALYSIS: COMPUTER PROGRAMS,**
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
V. P. Singh, and K. Arora.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-139795/AS. Price codes: A08 in paper copy; A01 in microfiche. Contract No. 14-08-0001-G1020. Project No. USGS G1020-06(1). Completion Report, March 1987. 144 p.

Descriptors: *Computer programs, *Flood frequency analysis, *Estimation, Model studies, Quantiles, Moment-direct, Moment-indirect, Mixed moments, Maximum likelihood estimation, Maximum entropy, Entropy estimation, At-site parameters, At-site analysis, Approximation.

Computer programs were used to assess the statistical performance indices of various estimators available for the flood frequency distribution under consideration. This involved three main phases of development: (1) generation of the pseudo-random numbers for the respective distribution, (2) estimation of parameters and quantiles by each of the available methods, and (3) computation of performance indices of bias, standard error, and root mean square error of the estimator. The generation of random numbers for the extreme value type I (EVI) and the two-component extreme value distributions is straightforward. Several alternative generation schemes were tested for generating the log Pearson type 3 (LP3) numbers. The schemes found most suitable (SUBROUTINE LP3GN4) consisted of generating one parameter gamma variates using IMSL routine and transforming them to LP3 numbers. Each of the available estimation methods for a given distribution was programmed as independent subroutine(s). These routines were thoroughly checked for round-off and convergence problems and debugged before using them in final simulation runs. Finally, after obtaining the parameter and quantile estimates from each of the estimators, their performance indices were calculated in a straightforward manner. The user can easily combine the various subroutines to obtain the parameter and quantile estimates by various estimators in a single run. Various standard IMSL routines perform a variety of lower level calculations. All programs have been run on WATFIV compilers supported by MVO/TSO or IBM 370/3033-3084. (Singh-LA, WRRI)
W88-05235

**USE OF WATER QUALITY MODELS IN BELGIUM,**
Brussels Univ. (Belgium). Lab. of Hydrology.
For primary bibliographic entry see Field 5G.
W88-05252

**ACTIVATED SLUDGE PROCESS CONTROL BY BEHAVIOUR OF SECONDARY SETTLING TANKS,**
Naples Univ. (Italy). Facolta di Ingegneria.
For primary bibliographic entry see Field 5D.
W88-05254

**TECHNICAL NOTE: PROPER USE OF THE UNIT MG AS CACO3/L,**
Auburn Univ., AL. Dept. of Civil Engineering.
S. R. Jenkins, J. M. Morgan, and J.-P. Nicol.
Journal of the American Water Works Association JAWWA5, Vol. 79, No. 9, p 122-124, September 1987. 3 tab, 1 ref.

Descriptors: *Calcium carbonate, *Chemical notation, *Charge equivalents, Alkalinity, Acidity, Hardness, Chemical properties, Chemical relationships, Chemical reactions, Molar units, Normality units.

The 1 unit milligrams as calcium carbonate/liter (mg as CaCO3/L) 1 should be used consistently to express charge equivalents of a solution. Confusion arises if this unit is used to express carbonate equivalents. Using consistent units (mg as CaCO3/L for charge equivalents), the total carbonate species was shown to be equal to the sum of the alkalinity and the acidity. (Author's abstract)
W88-05389

**PROCESS-ORIENTED ESTIMATION OF SUSPENDED SEDIMENT CONCENTRATION,**
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-05403

**COMPARISON OF METHODS FOR ESTIMATING LOW FLOW CHARACTERISTICS OF STREAMS,**
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2E.
W88-05410

**NONLINEAR SOLUTIONS OF THE BOUSSINESQ EQUATION AND COMPARISONS WITH FIELD OBSERVATIONS,**
Technical Univ. of Lodz (Poland).
For primary bibliographic entry see Field 2F.
W88-05411

**LIMITATIONS OF CONCEPTS USED TO DETERMINE INSTREAM FLOW REQUIREMENTS FOR HABITAT MAINTENANCE,**
Nebraska Univ., Lincoln. Inst. of Agriculture and Natural Resources.
For primary bibliographic entry see Field 2E.
W88-05421

**RULE-BASED MODEL OF DESIGN JUDGMENT ABOUT SLUDGE BULKING,**
Kereomel Environmental Systems Analysts, Champaign, IL
For primary bibliographic entry see Field 5D.
W88-05510

**CYCLES IN FINITE SAMPLES AND CUMULATIVE PROCESSES OF HIGHER ORDERS,**
National Hydrology Research Inst., Saskatoon (Saskatchewan).
V. Klemes, and I. Klemes.
Water Resources Research WRERAO, Vol. 24, No. 1, p 93-104, January 1988. 10 fig, 1 tab, 29 ref.

Descriptors: *Cyclic processes, *Statistics, *Mathematical studies, *Statistics, *Cycles in finite samples, *Cumulative processes, *Mathematical equations, Errors, Water level fluctuations, Dams, Lakes, Glaciers, Model studies.

The process formed by a sequence of cumulative departures from the mean or from some other constant (residual mass curve, cusum chart) is a popular tool for the representation and analysis of time series in many sciences. Cumulative processes often arise naturally as in fluctuations of storage in a dam with a constant release rate, lake levels, or volumes of glaciers. Components of cumulative processes of higher orders (ie., cumulative processes of cumulative processes) may also be represented. Specific mathematical equations are presented to show that the nth order residual mass curves computed for a finite interval of length N rapidly converge to a sine wave with a period equal to N for most empirical and theoretical functions. This happens to any initial sample and the convergence is of an exponential order. For samples of most stochastic and deterministic processes, the period of the limiting sine wave is equal to the sample size; examples from various processes are included. The effects of noise superimposed on, and of error in the value of, sample mean on the rate of convergence are demonstrated and some practical implications of the phenomenon are described. (Wood-PTT)
W88-05534

**ANALYTICAL MODELS OF SLUG TESTS,**
Lawrence Berkeley Lab., CA. Earth Sciences Div.
For primary bibliographic entry see Field 2F.
W88-05536

**SURVEY CHARACTERIZES THE SMALL WATER SYSTEM,**
Alabama Rural Water Association, Montgomery.
For primary bibliographic entry see Field 5F.
W88-05558

**BUILDING AN EFFECTIVE COMPUTER MAPPING PROGRAM,**
Metropolitan Sewer District of Greater Cincinnati, OH. Div. of Wastewater Engineering.
For primary bibliographic entry see Field 5D.
W88-05565

**COMPARATIVE ASPECTS OF COMPUTERIZED FLOODPLAIN DATA MANAGEMENT,**
Middlesex Polytechnic, London (England). School of Geography and Planning.
For primary bibliographic entry see Field 6A.
W88-05611

**DEVELOPMENT OF THE RIO DE LA PLATA SYSTEM,**
For primary bibliographic entry see Field 6E.
W88-05613

**WATER RESOURCES ANALYSIS USING ELECTRONIC SPREADSHEETS,**
Southwest Florida Water Management District, Brooksville.
M. C. Hancock, and J. P. Heaney.
Journal of Water Resources Planning and Management (ASCE) JWRMD5, Vol. 113, No. 5, p 639-658, September, 1987. 5 fig, 17 ref, 6 append.

Descriptors: *Computers, *Automation, *Water resources development, *Data processing, *Data interpretation, *Simulation, *Model studies, Resources development, Mapping, Hydrologic budget, Runoff, Routing, Flood routing, Surface-groundwater relations, Evaporation, Case studies, Flow characteristics, Mathematical analysis.

Electronic spreadsheet software developed for microcomputers provides a means by which an engineer can prepare and analyze data, estimate model parameters, perform desktop calculations, and thoroughly document all work. This paper presents ways to use spreadsheets to perform a variety of tasks related to solving water resources problems. Applications include database management, simple computer mapping, spatial data analysis, a hydrologic budget, trend analysis, a runoff simulation, a flood routing simulation, and a continuous surface-groundwater model. Examples from a recently completed water resources study are included. The spreadsheets may be used as a pre- and/or postprocessor for mainframe computer models; they can also be used to create simpler hydrologic models that are easy to understand and can be customized to the local conditions. Copies of the spreadsheet files can be obtained from the University of Florida. (Author's abstract)
W88-05639

**NOTES ON SEDIMENTATION ACTIVITIES, CALENDAR YEAR 1986.**
Geological Survey, Reston, VA. Office of Water Data Coordination.
For primary bibliographic entry see Field 2J.
W88-05745

**MICROCOMPUTER PROGRAMS FOR GROUNDWATER STUDIES,**
For primary bibliographic entry see Field 2F.
W88-05778

**REMOTE SENSING: METHODS AND APPLICATIONS,**
MRJ, Inc., Oakton, VA.
For primary bibliographic entry see Field 7B.
W88-05780

**REMOTE SENSING AND IMAGE INTERPRETATION,**
Wisconsin Univ.-Madison.
For primary bibliographic entry see Field 7B.
W88-05781

**GEOLOGICAL INTERPRETATION OF WELL LOGS,**
Rider-French Consulting Ltd., Cambridge (England).
M. H. Rider.
John Wiley and Sons, New York, NY. 1986. 175 p.

Descriptors: *Logging (Recording), *Data interpretation, *Data acquisition, *Well logs, *Rock properties, Geohydrology, Hydrocarbons, Geology, Groundwater.

Traditionally, the analysis of well logs has been left to the petrophysicist, whose brief is to quantify reservoir parameters and, in particular, the amount of indicated hydrocarbons. The petrophysicist may state that a reservoir has 20% porosity and a water saturation of 35%. However, the logs can also tell us what the sandstone is in a fining upwards sequence and was probably deposited in a fluvial channel associated with a cycle of deltaic progradation. It is the latter aspects, rather than quantitative petrophysics, that are considered in this book. The early chapters consider each of the principal open hole logging tools. Measurements made by each tool are discussed in terms of simple theory and acquisition of data. The geological interpretation is then described, using many field examples, logs being accompanied by a relevant interpretation wherever possible. The later chapters bring together the log data from earlier parts of the book to form single data sets. This complete interpretation is shown to provide geological information which is as detailed as that at outcrop. (Lantz-PTT)
W88-05782

**EMPIRICAL METHODS FOR PREDICTING EUTROPHICATION IN IMPOUNDMENTS. REPORT 4: PHASE III, APPLICATIONS MANUAL,**
W. W. Walker.
Available from the National Technical Information Service, Springfield, VA. 22161 as ADA-188261. Price codes: A14 in paper copy; A01 in microfiche. Technical Report E-81-9, July 1987. Report 4 of a Series. 298 p, 22 fig, 26 tab, 39 ref. Contract No. DACW39-78-C-0053-P006.

Descriptors: *Mathematical methods, *Eutrophication, *Water quality control, *Forecasting, *Manuals, *Reservoirs, Nutrients, Computer programs, Phosphorus, Nitrogen, Chlorophyll-a, Oxygen, Data interpretation, Algal growth, Seasonal variation.

Eutrophication has several direct and indirect effects on reservoir water quality and uses. The report documents assessment procedures which have been developed for application to Corps of Engineer reservoirs. Study phases include problem identification, data gathering, data reduction, and model implementation. Three computer programs are designed to assist in the last two phases: (1) FLUX - estimation of tributary nutrient loadings from grab-sample concentration data and continuous flow records using a variety of calculation methods which permit quantification of potential errors and evaluation of alternative sampling program designs; (2) PROFILE - display and reduction of pool water quality data, including calculation of hypolimnetic oxygen depletion rates, characterization of spatial and temporal variability, and robust statistical summary of mixed-layer concentration data; and (3) BATHTUB - implementation of nutrient balance models and eutrophication response models in a spatially segmented hydraulic network which accounts for advective transport, diffusive transport, and nutrient sedimentation. Eutrophication-related water quality conditions (expressed in terms of total phosphorus, total nitrogen, chlorophyll-a, transparency, organic nitrogen, particulate phosphorus, and hypolimnetic oxygen depletion rate) are predicted using empirical relationships which have been calibrated and tested for reservoir applications. Based upon research using several independent data sets, previous 'northern-lake-based' empirical modeling approaches have been modified to account for effects of: (1) nonlinear nutrient sedimentation kinetics; (2) algae growth limitation by phosphorus, nitrogen, light, and flushing rate; (3) inflow nutrient partitioning; (4) seasonal variations in loadings and morphometry; and (5) spatial variations in nutrients and related trophic state indicators. To reflect input data limitations and inherent model errors, inputs and outputs can be expressed in probabilistic terms. The segmented model can be applied to single reservoirs, partial reservoirs, networks of reservoirs, or collections of reservoirs. The last type of application permits regional comparative assessments of reservoir conditions, controlling factors, and model performance. (Author's abstract)
W88-05861

**STATISTICAL ASPECTS OF WATER QUALITY MONITORING.**
Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Developments in Water Science, No. 27, Elsevier, New York. 1986. 502 p. Edited by A. H. El-Shaarawi and R. E. Kwiatkowski.

Descriptors: *Statistics, *Statistical methods, *Water quality control, *Monitoring, *Data interpretation, Conferences, Information exchange, Time series analysis, Statistical models, Model studies, Quality control, Data acquisition.

Statistics provides a collection of techniques for extracting maximum information from a given data set and allows the construction of strategy for future data collection. These techniques have proven invaluable in such fields as agriculture, medical science and business. However, in the area of environmental sciences, statistical applications are still in their infancy, with few attempts to systematically develop techniques dealing with environmental issues. This workshop was an attempt to bring together international scientists, statisticians, and users of statistical methodology in limnology, water quality regulation and control, monitoring network design, and, modelling of aquatic environments. The prime objective of the Workshop was to generate interaction between the statistical community and scientists working in the area of Water Quality Monitoring. To this end, topics covered in this Workshop fall into two categories: (1) Methods Development, and (2) the Imaginative Application of Existing Methodologies. Subjects covered include: Time Series, Estimation of Loading, Clustering, Model Development, Censoring Data Analysis, Quality Control and Data Acquisition. (See W88-05863 thru W88-05899) (Lantz-PTT)
W88-05862

**SPATIAL HETEROGENEITY OF WATER QUALITY PARAMETERS,**
Canada Centre for Inland Waters, Burlington (Ontario).
S. R. Esterby.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 1-16, 1 fig, 1 tab, 37 ref.

Descriptors: *Statistics, *Spatial heterogeneity, *Water quality, *Data interpretation, *Statistical methods, Statistical analysis, Autocorrelation, Cluster analysis.

The many dimensions of water quality data sets make analysis difficult. Data is often collected to meet objectives related to monitoring the change in water quality conditions which are necessarily too general to be of help in reducing the dimensions of the problem. Thus, cluster analysis and related methods, which do not use the spatial location but can be used to examine the structure of multivariate data, are complementary to the univariate methods which do use the spatial location. The analyst can expect to use the various classes of methods discussed in an iterative fashion, coupled with scientific understanding of the system, to arrive at a characterization of spatial structure. Of the methods discussed (grouping methods, spatial autocorrelation methods and methods which involve fitting a function for the relationship between a water quality parameter and location, with or without the assumption of independence), only the grouping procedures are strictly for the purpose of discovering structure in the data. The other methods, even in the characterization stage, are used for testing hypotheses and estimation. (See also W88-05862) (Lantz-PTT)
W88-05863

**UNCERTAINTY IN WATER QUALITY DATA,**
Colorado State Univ., Fort Collins. Environmental Engineering Program.
R. H. Montgomery, and T. G. Sanders.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 17-29, 1 fig, 11 ref. OWRT Grant No. 14-08-001-G-1060.

Descriptors: *Statistics, *Data interpretation, *Water quality, Sampling, Data collection, Uncertainty, Statistical analysis.

Water quality data are collected to provide information to assist in the understanding and managing of water resources. The usefulness of water quality

data collected is inversely related to the amount of uncertainty in the data. Data uncertainty may be defined as a state of doubt in how representative observed values are of the true population characteristics. Data uncertainty may be estimated as a function of both sampling and nonsampling errors. Sampling errors result from the sampling network design (location and frequency of sample collection) which samples only a subset of the total population. Nonsampling errors result from the process of measuring the amount of water quality material present. The measurement process may be divided into sample collection and laboratory analysis. Sample collection includes the physical procedure for obtaining, storing, and transporting a water sample for later analysis. Laboratory analysis consists of some method of estimating the amount (concentration) of a given material in the water sample. A general discussion of the sources of water quality data uncertainty, a method to estimate data uncertainty in water quality variables, and the implications of uncertainty in water quality data are discussed. (See also W88-05862) (Author's abstract)
W88-05864

**USE OF MULTIVARIATE METHODS IN THE INTERPRETATION OF WATER QUALITY MONITORING DATA OF A LARGE NORTHERN RESERVOIR,**
R. Schetagne.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 30-43, 6 fig, 2 tab, 13 ref.

Descriptors: *Statistics, *Statistical analysis, *Data interpretation, *Water quality, *La Grande Reservoir, Monitoring, Quebec, Water quality control, Hydrogen ion concentration, Dissolved oxygen, Chlorophyll a, Nutrients, Cluster analysis, Organic matter, Mixing, Statistical methods.

An ecological monitoring network has been established on the La Grande Complex, Quebec, Canada. Water quality studies of the La Grande 2 reservoir were initiated in 1977, two years before its impoundment, and continued for five years after its filling. Principal component analyses were successfully used to single out the parameters showing the greatest changes (pH, dissolved oxygen, chlorophyll a and a number of nutrients), and to present the data in a clear and synthetic manner. Hierarchical clustering analysis provided good results when used on bottom data where redox decline triggered sharp chemical changes. These methods showed that the process of decomposition of submerged organic matter and the simple mixing of waters of different quality account for most of the changes measured. (See also W88-05862) (Author's abstract)
W88-05865

**MODELING RIVER ACIDITY - A TRANSFER FUNCTION APPROACH,**
Norsk Regnesentral, Oslo.
E. Damsleth.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 44-52, 4 fig, 2 tab, 8 ref.

Descriptors: *Statistics, *Statistical models, *Water quality, *Acid rain, *Acidity, *Nid River, *Mandal River, *Tovdal River, Transfer function, Norway, Hydrogen ion concentration, Monitoring, Water pollution sources, Industrial wastewater, Model studies, Seasonal variation, Chemical analysis.

Hydrogen ion concentration data from three rivers in Southern Norway has been analyzed. In the Nid River and Tovdal River observations were taken weekly, while the pH in the Mandal River was observed twice a month. All three series are well described by simple, univariate ARIMA-models. A small, but significant, term is included to account for the seasonal variation in the series. The model structure is very similar for all three rivers. Two of the rivers, Nid River and Mandal River, are exploited extensively for power production. Most of the discharge in these rivers consists of storage water, which is known to have a more stable water chemistry as compared to rivers which run freely. This is reflected in the residual standard deviation of the pH, which is much larger for the unexploited river. The discharge affects the acidity in all the three rivers. The relationship between flow and pH has been described in a transfer function model, where the input is the logarithm of the average discharge during the last seven days prior to the pH observation. The effect, however, is much more pronounced in the two exploited rivers, which again can be explained by the stable chemistry of the storage water. The use of discharge as input to the model has removed most of the seasonal variation in all three series. For the controlled rivers it is fairly satisfactory to apply the same model for the whole river, independent of the season. For the uncontrolled Tovdal River, this is not the case; Here the relation between discharge and acidity exists only during the summer and autumn. The explanation lies in the snow, which stores most of the water during the winter and early spring, discharging it during the spring flood. The analysis gives no reason to say that there has been any systematic trend in the river acidity. After adjustment for the variations in the discharge, there is vague evidence that the rivers have been significantly more acid during the years 1977-79. (See also W88-05862) (Lantz-PTT)
W88-05866

**SULPHATE, WATER COLOUR AND DISSOLVED ORGANIC CARBON RELATIONSHIPS IN ORGANIC WATERS OF ATLANTIC CANADA,**
Inland Waters Directorate, Ottawa (Ontario). Water Quality Branch.
For primary bibliographic entry see Field 5A.
W88-05867

**SULFATE IN COLOURED WATERS. I. EVALUATION OF CHROMATOGRAPHIC AND COLORIMETRIC DATA COMPATIBILITY,**
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 5A.
W88-05868

**DETERMINATION OF WATER QUALITY ZONATION IN LAKE ONTARIO USING MULTIVARIATE TECHNIQUES,**
Inland Waters Directorate, Burlington (Ontario). Water Quality Branch.
M. A. Neilson, and R. J. J. Stevens.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 99-116, 7 fig, 4 tab, 27 ref.

Descriptors: *Statistics, *Water quality, *Lake Ontario, *Multivariate analysis, *Data interpretation, Statistical analysis, Statistical methods.

The surface water quality characteristics of Lake Ontario were studied during 29 cruises conducted on a monthly basis throughout 1977, 1981 and 1982. El-Shaarawi and Shah's classification procedure was first used to reduce each year's multicruise information (each cruise sampling 94 stations for 14 parameters) to a single value (T) for each station and year. Principal components analysis was then applied to these T-values, reducing the multiple parameter list to 3 factor scores. Ward's clustering procedure grouped together stations, according to their factor scores, which demonstrated similar properties. These groups, or zones, were then validated using discriminant analysis. This analysis revealed that 74, 90 and 90% of the stations in 1977, 1981 and 1982, respectively, were correctly classified. When a station is designated as being misclassified, it demonstrates a higher probability of belonging to a zone other than that to which it was originally assigned. Where the predicted zone did not correspond to the actual zone (ie., the group for which the station showed the greatest probability of membership), the second highest probability zone was, in almost all cases, the originally proposed zone. In this study, the greatest percent of misclassifications occurred between zones 5 and 6. This is not unexpected due to the variation in areal extent of these two midlake zones during the three years. (See also W88-05862) (Lantz-PTT)
W88-05870

**SPATIAL VARIABILITY IN THE WATER QUALITY OF QUEBEC RIVERS,**
Quebec Ministere de l'Environnement, Sainte-Foy.
M. Simoneau.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 117-135, 5 fig, 2 tab, 10 ref.

Descriptors: *Statistics, *Quebec, *Spatial variability, *Water quality, *Rivers, *Data interpretation, Monitoring, Multivariate analysis, Statistical analysis, Statistical methods, Cluster analysis, Principal component analysis.

The spatial variability of the water quality of Quebec rivers was studied using data collected over a five-year period (1979-1983). These data, which were obtained through the operation of a monitoring network, were analyzed using multivariate analytical methods. A principal component analysis (PCA) was used to condense the information contained in the data matrix and to identify the physical chemical parameters responsible for the major portion of the among stations variance. A cluster analysis (using the squared Euclidean distance as similarity coefficient and Ward's method as an agglomerative hierarchical clustering algorithm) was performed to reveal the presence of homogeneous water quality regions in the province. The PCA produced two significant principal components which explain 76% of the among stations variance. The first axis (51%) represents a mineralization and nutrient gradient whereas the second (25%) represents an organic content and color gradient. The cluster analysis has revealed the presence of six distinct groups, whose water quality reflects the geology of the different basins and, to various degrees, the anthropogenic activities. One of these groups is composed of twelve problem-stations, most of which are found in drainage basins with small surface area affected by local point source pollution. (See also W88-05862) (Author's abstract)
W88-05871

**ESTIMATION OF DISTRIBUTIONAL PARAMETERS FOR CENSORED WATER QUALITY DATA,**
Geological Survey, Reston, VA.
D. R. Helsel.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 137-157, 8 fig, 1 tab, 6 ref.

Descriptors: *Statistics, analysis, *Statistics, *Data interpretation, *Water quality, *Distribution patterns, Water pollutants, Statistical methods.

For some chemicals, established water quality criteria are below commonly applied detection limits. For many others, the great uncertainty in the effects of long-term exposure to very low levels also make it desirable to assess the frequency of occurrence of concentrations below the detection limit. In short, there is a need to estimate the frequency distribution of concentrations above, near, and below detection limits using only data above the detection limit. Key aspects of estimating distributional parameters from censored data include: The performance of several estimation methods when estimating distributional parameters from small samples drawn from a wide range of underlying distributions and censored to varying degrees; Criteria for determining, based only on attributes of data remaining after censoring, which estimation method is most likely to be best for each data set; and, The reliability of estimates from

censored data of four distributional parameters: the mean, standard deviation, median, and interquartile range. The most robust estimation method for minimizing errors in estimates of the mean, standard deviation, median, and interquartile range of censored data was the log-probability regression method (LR). This method is based on the assumption that censored observations follow the zero-to-censoring level portion of a lognormal distribution obtained by a least-squares regression between logarithms of uncensored concentration observations and their normal scores. When method performance was evaluated separately for each distributional parameter, LR resulted in the lowest root mean square errors (RMSEs) for the mean and standard deviation. The lognormal maximum likelihood estimator for censored data (LM) produced lowest RMSEs for the median and interquartile range. These two methods constitute the best procedures for their respective parameters. (See also W88-05862) (Lantz-PTT)
W88-05872

**EXTENSION OF WATER QUALITY DATA BASES IN PLANNING FOR WATER TREATMENT,**
California Univ., Davis.
For primary bibliographic entry see Field 7B.
W88-05874

**STATISTICAL INFERENCES FROM COLIFORM MONITORING OF POTABLE WATER,**
W. O. Pipes.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 183-193, 2 fig, 3 tab, 4 ref.

Descriptors: *Statistics, *Statistical analysis, *Monitoring, *Water quality, *Coliforms, *Potable water, Data interpretation, Performance evaluation, Microbiological studies, Heterogeneity.

Routine monitoring of water distribution systems for coliform bacteria for regulatory purposes has resulted in the recognition of several interesting statistical problems. A reasonably large body of statistical literature dealing with some of these problems has developed over the last 75 years but there are still problems which need additional study. One problem is the estimation of mean coliform density. Most of the sample results are indeterminate, either too high or too low for the available methods to measure accurately. A technique for estimation of an average from indeterminate value would probably be of great benefit in several different scientific fields but, short of that, it is probably better to use some parameters other than mean density for regulatory purposes. The normal reporting period of microbiological drinking water quality is one month, but there is no scientific basis for using a month rather than a week or a year. The question of the persistance of microbiological water quality in a distribution system needs to be investigated further in relation to regulation and monitoring. Under present regulations in the United States, the number of samples per month required for microbiological monitoring runs from 1/month to 500/month and increases with increasing size of the water distribution system. Sampling theory suggests that the number of samples needed is not related to the size of the system. There may be differences in microbiological water quality among different areas of a water system and larger systems probably have greater heterogeneity. This greater heterogeneity may be a rationale for requiring more samples for larger systems. This also needs further study. (See also W88-05862) (Lantz-PTT)
W88-05875

**MODELLING OF BACTERIAL POPULATIONS AND WATER QUALITY MONITORING IN DISTRIBUTION SYSTEMS,**
Centre des Sciences de l'Environment, Metz (France).
For primary bibliographic entry see Field 5A.
W88-05876

**GOODNESS-OF-FIT TEST FOR THE NEGATIVE BINOMIAL DISTRIBUTION APPLICABLE TO LARGE SETS OF SMALL SAMPLES,**
Illinois Inst. of Tech., Chicago. Dept. of Mathematics.
B. Heller.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 215-220, 4 tab, 12 ref.

Descriptors: *Statistics, *Binomial distribution, *Data interpretation, *Statistical analysis, Bacteria, Statistical methods, Model studies, Poisson ratio.

In microbiological work, bacterial counts are often obtained serially in time or in space. If there are replicates, they are few in number. If it is assumed that the same probability model can be used for the whole set of counts, then parameter values might vary from one point in time to the next. An attempt was made to devise a goodness-of-fit test for a given probability model, taking into account the effect of varying parameters and small sample sizes, using a case where the assumed model is negative binomial. Various alternative distributions to the negative binomial model which are in common use, are noted. On the one hand, if the data derive from a Neyman Type A or Poisson-with-added-zeros distribution, the expected value of statistic T, is negative. Therefore it can be expected that the test statistics A and C are 'too' negative. On the other hand, if the data are from the logarithmic-with-zeros distribution, the statistics A and C will have positive expected value and values which are 'too' positive are expected. (See also W88-05862) (Lantz-PTT)
W88-05877

**REPORTING BACTERIOLOGICAL COUNTS FROM WATER SAMPLES: HOW GOOD IS THE INFORMATION FROM AN INDIVIDUAL SAMPLE,**
Central Public Health Lab., London (England). Communicable Disease Surveillance Centre.
For primary bibliographic entry see Field 5A.
W88-05878

**SOME APPLICATIONS OF LINEAR MODELS FOR ANALYSIS OF CONTAMINANTS IN AQUATIC BIOTA,**
University of Western Ontario, London.
R. H. Green.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 231-245, 4 fig, 18 ref, 2 append.

Descriptors: *Statistics, *Data interpretation, *Water quality, *Linear analysis, *Statistical models, Case studies, Statistical analysis, Monitoring, Simulation analysis.

Log-log linear models and some examples of their application to water quality monitoring are discussed. Such models arise out of any situation where it is desired to estimate a proportion, percentage, or ratio which is in practice calculated from two other observable variables. The common practice of actually calculating this derived variable for each sampled observation, and then using the desired value as the response variable in a statistical model such as ANOVA, leads to problems of both statistical analysis validity and of interpretation of the results. Log-log regression or analysis of covariance (ANCOVA) models can usually satisfy the objectives in such studies without derived variables being used in statistical analysis. The problem and this solution to it were explained by an example, which does not relate to water quality monitoring, the water content of spring and fall frogs. Three examples which are in a water quality monitoring context are presented: (1) biomagnetification of a contaminant; (2) ratio of isotopes of elements in biogenic material; and (3) ratios of sensitive species to resistant species as a community index of water quality. All four examples are based on simulated data, so that known parameters can be estimated by statistical procedures which can then be evaluated by their success in testing hypotheses whose truth or falsehood are known. (Lantz-PTT)
W88-05879

**COMPARATIVE STUDY OF THE SAMPLING PROPERTIES OF FOUR SIMILARITY INDICES,**
For primary bibliographic entry see Field 7B.
W88-05880

**RANDOMIZED SIMILARITY ANALYSIS OF MULTISPECIES LABORATORY AND FIELD STUDIES,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Statistics.
E. P. Smith.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 261-272, 1 fig, 3 tab, 24 ref. NIH Grant No. 18770.

Descriptors: *Statistics, *Data interpretation, *Field tests, *Water quality, Species diversity, Sampling, Statistical methods, Permutation, Randomization, Similarity, Statistical analysis.

The analysis of biological data arising from multispecies studies is discussed. Three basic questions arise in these studies: (1) Whether there are differences due to the locations or treatments; (2) Which species are primarily involved in the differences; and (3) Whether the locations or treatments are different. The primary inferential method proposed is based on permutation or randomization procedures. Here, the methods are based on comparing similarities between samples from like and unlike sites. Similarities or measures of distance between species are commonly used to compare sites. However, most of the comparisons tend to be graphical and not based on an inferential procedure. The permutation methods presented are complemented by graphical and summary measures to aid in interpreting the test results. (Lantz-PTT)
W88-05881

**GAMMA MARKOV PROCESSES,**
Monash Univ., Clayton (Australia).
R. M. Phatarfod.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 293-301, 10 ref.

Descriptors: *Statistics, *Markov process, *Data interpretation, *Water quality, Mathematical analysis, Statistical models, Dissolved oxygen, Suspended solids, Water pollution sources.

The statistical problem of monitoring of water quality over time is essentially a study of the time series of some variable of interest such as dissolved oxygen, suspended solids, various kinds of chemicals, organic matter and other impurities, the values being observed at various intervals of time, such as a day, a week or a month. In one such situation, the observations are made on the input source, such as a river and the problem of interest is the effect the observed values (or a statistical model of it) would have on the value of some parameter in the body of water fed by that river. An example of such a problem is: having observed the concentration of suspended solids in the river over a period of years, to determine the probability distribution of the totality of the load of that type in the lake in the future. The application of Gamma Markov processes to simulating a model of this problem is illustrated. (See also W88-05862) (Lantz-PTT)
W88-05883

**DYNAMIC COVARIATE ADJUSTMENT OF WATER QUALITY PARAMETERS FOR STREAMFLOW: TRANSFER FUNCTION MODEL SELECTION,**
Vermont Univ., Burlington.
L. D. Haugh, Y. Noda, and J. McClallen.

IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 302-317, 5 fig, 3 tab, 12 ref.

Descriptors: *Statistics, *Water quality, *Streamflow, *Model studies, *Data interpretation, *LaPlatte River, *Vermont, *Transfer function, Phosphorus, Suspended solids, Model studies, Time series analysis, Flow rates, Seasonal variation.

Weekly concentration data for total phosphorus and total suspended solids, as well as mean weekly flow, were studied for a period fo 229 weeks (mid 1979 to late 1983) at one station in the LaPlatte River Watershed of Vermont. The autocorrelation patterns in these data and their stationarity in the mean are described via selection of univariate ARIMA time series models. The relationship of the concentration data to the flow data is modelled by the selection of a transfer function model. Contrasts are drawn between stationary and nonstationary (first order differenced) models. The relative advantage of the flow-dependent model for understanding trends in concentration is considered. The model provides a dynamic adjustment, or covariate analysis, of concentration changes due to flow, which would be critical in assessing intervention effects. Such a model also captures seasonal variation in concentration via the seasonal variation in flow. (See also W88-05862) (Author's abstract)
W88-05884

**RESIDUALS FROM REGRESSION WITH DEPENDENT ERRORS,**

University of Western Ontario, London. Dept. of Statistical and Actuarial Sciences.
R. J. Kulperger.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 318-325, 2 fig, 10 ref. NSERC Grant No. A5724.

Descriptors: *Statistics, *Statistical methods, *Data interpretation, *Statistical models, Regression analysis, Autoregression, Simulation analysis.

Regression models are very useful in practice, whether the interest is with residuals obtained after fitting the parameters, or with a dependent, autoregressive process. Some properties of the residuals are considered for simple regression cases. Results in an autoregressive with no regression case are also summarized, with specific remarks addressing differencing. Some simulation examples are used to illustrate these results. (See also W88-05862) (Lantz-PTT)
W88-05885

**ALTERNATIVES FOR IDENTIFYING STATISTICALLY SIGNIFICANT DIFFERENCES,**

E. A. McBean.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 326-334, 1 fig, 3 tab, 5 ref.

Descriptors: *Water pollution effects, *Statistics, *Data interpretation, *Statistical analysis, *Statistical methods, Statistical significance, T-test, Sampling, Monitoring.

The need to discriminate between two or more sets of data is commonplace. Examples where discrimination is needed include the determination of the impact of an implemented remedial technology and the examination of whether a nonpoint pollutant source is producing a statistically significant impact. In responding to these types of questions requiring analysis, a number of testing procedures have been utilized. However, in selecting the procedure for use in a particular application, there are no absolute rules, only guidelines. The most frequently used procedure for environmental problems is the t-test. There are assumptions implicit to the test which require different approaches in application to a problem. To make inferences about the means of small samples, the t-distribution which describes the distribution of the means of small samples from a normally distributed population, is frequently chosen as the reference. Whether this test is valid or not depends somewhat upon the purpose of the testing and how the test is applied. The concept of 'statistical significance' must be reflected in a number of aspects of the monitoring program involving not just the choice of the level of significance but also the choice of the test, and the requirements of the number of samples. (See also W88-05862) (Lantz-PTT)
W88-05886

**GLOBAL VARIANCE AND ROOT MEAN SQUARE ERROR ASSOCIATED WITH LINEAR INTERPOLATION OF A MARKOVIAN TIME-SERIES,**

Quebec Univ., Sainte-Foy.
D. A. Cluis.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 335-346, 1 fig, 3 tab, 1 ref.

Descriptors: *Statistics, *Data interpretation, *Water quality, *Root mean square, *Markov process, *Time series analysis, Statistical analysis, Linear analysis.

Most general-purpose data acquisition networks provide equispaced instantaneous information; the frequency of measurements necessary to obtain this information efficiently is related to the intrinsic temporal variability of the given phenomenon. In the field of water quality monitoring, the estimation of mass-discharges is a prerequisite for the interpretation of transport phenomena, source-effects relationships and trend detection. To evaluate this important secondary variate, one must combine high frequency/high variability flow data with low frequency/low variability concentration data; this can be done by using some combination of aggregation and interpolation of data. The aggregation of high frequency data has relatively minor effects. However, the spreading of the information resulting from linear interpolation creates a certain level of heteroscedasticity and also produces an error of estimation, the variance of which increases with the number of partitions. For phenomena exhibiting short-term positive Markovian persistence, the analytical expression for the global variance of the estimation error was first established for skipped series derived from actual measurements: using the self-similar persistence structure of the Markovian processes, the Root Mean Square Error (RMSE) of the interpolated time-series was deduced. Thus, a criterion relating the short-term persistence to the number of partitions allows one to control and limit the level of error in the transformed time-series. Within the context of large Markovian samples, the global variance and the expected RMSE of estimation resulting from iterative linear interpolation (ILI) have been derived. The results show that the level of error introduced by ILI is more sensitive to the persistence parameter, than to the level of realized partition. (See also W88-05862) (Lantz-PTT)
W88-05887

**EMPIRICAL POWER COMPARISONS OF SOME TESTS FOR TREND,**

Waterloo Univ. (Ontario). Dept. of Systems Design Engineering.
K. W. Hipel, A. I. McLeod, and P. K. Fosu.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 347-362, 1 fig, 6 tab, 36 ref.

Descriptors: *Statistics, *Water quality, *Statistical methods, *Data interpretation, Kendall's tau, Correlation analysis, Correlation coefficients, Statistical analysis, Simulation analysis, Mathematical studies.

An important consideration in environmental impact assessment is whether a set of data is random or whether a systematic trend is present. There have been several investigations (both theoretical and empirical) of test statistics to be used to test for randomness. An overwhelming majority of the test statistics currently used are nonparametric. Kendall and Stuart developed and employed statistics which include the turning point test, the sign test, Kendall's tau, and the rank correlation coefficient. Using Monte Carlo studies, the powers of Kendall's tau and the lag-one serial correlation were compared for detecting trends in time series. Simulation experiments demonstrate that tests based on Kendall's tau are more powerful than serial correlation tests for discovering deterministic trends. On the other hand, the lag-one serial correlation is more powerful when only purely stochastic trends are present. (See also W88-05862) (Lantz-PTT)
W88-05888

**STATISTICAL ASSESSMENT OF A LIMNOLOGICAL DATA SET,**

Rensselaer Polytechnic Inst., Troy, NY.
R. Clifford, J. W. Wilkinson, and N. L. Clesceri.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 363-380, 5 fig, 6 tab, 20 ref, append.

Descriptors: *Statistical analysis, *Limnology, *Data interpretation, *Wisconsin, Phosphorus, Analysis of variance, Statistical models, Statistical methods.

In a study of Wisconsin Lakes, to examine the effects upon water quality of imposition of a ban on detergent phosphorus, the design protocol employed the concept of test lakes and reference lakes. A pairing was made of each test lake with a reference lake having as many similar characteristics as possible with the test lake except for a loading of phosphorus from municipal wastewater effluent or septic tank seepage. The responses measured for each lake were physical, chemical and biological in nature. Measurements were taken both before and after imposition of the ban. To estimate the potential effect of the ban, three forms of statistical models were used: (1) for each test lake a model using the reference lake variable as a covariate and the ban as a classification variable; (2) a comprehensive model for all of the lakes combined using the reference lakes as covariates and the test lakes as dummy variables; and (3) multivariate models providing multiple comparison estimates for pre- and post-ban differences. The advantage to the paired lake approach is the potential for variance reduction, and an examination of this was made for several data sets. The comparisons of the modeling procedures, estimates of the 'ban effects', and some of the observed distributional characteristics of the measured responses, are discussed. An effect of the phosphate ban, if any, was sufficiently small that detection with statistical significance was not possible with the amount of variability observed in the data. The multivariate/multiple comparison analysis would only have been capable of detecting a ban effect if there had been much more data or the measurement variability was greatly reduced. (See also W88-05862) (Author's abstract)
W88-05889

**CHANGE POINT PROBLEM: A REVIEW OF APPLICATIONS,**

University of Western Ontario, London.
V. K. Jandhyala, and I. B. MacNeil.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 381-387, 20 ref.

Descriptors: *Statistics, *Data interpretation, *Literature review, Statistical methods, Simulation analysis, Model studies, Statistical models.

In the context of process inspection schemes, a test was proposed for a change in a parameter occurring at an unknown time point. Those papers that contain analysis of statistical models applied to real data are reviewed. The first such paper (in 1971)

studied the change in behavior of stagnant surface layer height in a controlled flow of water down an inclined plane using different surfactants. The data were analyzed by modeling them using a two-regime transition model. The change in pollen concentration in a lake-sediment core was analyzed by making inferences about the point at which changes occur in the relationship between concentration and depth and modelling the data using regression techniques. The series of annual flows of the Nile was also analyzed for unknown interventions during the period 1870-1945 by treating it as a change point problem. (See also W88-05862) (Lantz-PTT)
W88-05890

**SPECTRAL ANALYSIS OF LONG-TERM WATER QUALITY RECORDS,**
Inland Waters Directorate, Vancouver (British Columbia). Pacific and Yukon Region.
For primary bibliographic entry see Field 5G.
W88-05891

**BAYES ESTIMATION OF PARAMETERS OF FIRST ORDER AUTOREGRESSIVE PROCESS,**
Yarmouk Univ., Irbid (Jordan). Dept. of Statistics.
M. S. Abu-Salih, and A. A. Abd-Alla.
IN: Statistical Aspects of Water Quality Monitoring. Proceedings of the Workshop held at the Canada Centre for Inland Waters, October 7-10, 1985. Elsevier, New York. 1986. p 405-417, 4 tab, 4 ref.

Descriptors: *Data interpretation, *Autoregression analysis, *Bayesian analysis, Statistical studies, Statistical analysis.

In order to compare the performance of the different Bayesian estimates used in this study, samples sizes of 50, 100, 150, and 200 were generated for each of the twenty-four (theta, sigma-squared) combinations of random parameter values, namely, for theta = -0.7, -0.4, -0.1, 0.2, 0.5, 0.8, and sigma = 0.5, 1.0, 1.5, and 2.0. For each combination of parameter values and sample size, 100 samples were generated. For each sample, estimates of theta and sigma were calculated. The mean and mean-square error (MSE) of each estimate were recorded. The values of estimates of theta by the different methods are very close to one another and very close to the assumed value. The same may be said about the estimates of sigma-squared, the larger the sample size the closer the results are to the assumed value. (See also W88-05862) (Lantz-PTT)
W88-05892

**SYSTEMS APPROACH TO COMPUTERIZING DATA ACQUISITION,**
For primary bibliographic entry see Field 7B.
W88-05893

**HIGH FREQUENCY WATER QUALITY MONITORING OF A COASTAL STREAM,**
Inland Waters Directorate, Vancouver (British Columbia). Pacific and Yukon Region.
For primary bibliographic entry see Field 7B.
W88-05894

**ESTIMATION OF MONTHLY MEAN PHOSPHORUS LOADINGS,**
Waterloo Univ. (Ontario).
For primary bibliographic entry see Field 5G.
W88-05896

**ESTIMATION OF LOADING BY NUMERICAL INTEGRATION,**
For primary bibliographic entry see Field 5B.
W88-05897

**INTERVENTION ANALYSIS OF SEASONAL AND NONSEASONAL DATA TO ESTIMATE TREATMENT PLANT PHOSPHORUS LOADING SHIFTS,**
Soap and Detergent Association, New York.
For primary bibliographic entry see Field 5D.
W88-05898

**SEDIMENT RESPONSES DURING STORM EVENTS IN SMALL FORESTED WATERSHEDS,**
Royal Military Coll., Duntroon (Australia). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W88-05899

**STATE-BY-STATE ENVIRONMENTAL DATA SUMMARIES.**
Conservation Foundation, Washington, DC.
For primary bibliographic entry see Field 6G.
W88-05900

**GROUNDWATER MODELLING: AN INTRODUCTION WITH SAMPLE PROGRAMS IN BASIC,**
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 2F.
W88-05908

# 8. ENGINEERING WORKS

## 8A. Structures

**SEISMIC RESPONSE OF DAM WITH SOIL-STRUCTURE INTERACTION,**
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 8D.
W88-05127

**HARBOR REVIVED,**
Warzyn Engineering, Inc., Madison, WI.
L. W. Ryan.
Civil Engineering CEWRA9, Vol. 57, No. 9, p 44-46, September 1987.

Descriptors: *Recreation, *Racine, *Wisconsin, *Harbors, *Redevelopment, *Marinas, Breakwaters, Engineering, Tourism.

The Racine Wis. harbor view had lost its appeal. In a drastic turn-around, the same lakeside property has more than tripled in value since city officials made a thriving business out of sailing for fun. As part of a harbor redevelopment plan, 920 slips are being constructed to lure pleasure boats from Chicago and Milwaukee to Racine waters. The downtown Racine Harbor area rehab was conceived by the Downtown Racine Development Corp. (DRDC), a group of 25 businesses formed in response to the area's economic stagnation. Construction officially began last summer, but unacceptable soil conditions delayed the real start-up until September when the soil compaction that was done on almost all of the 5.5 acres developed was completed. Two 0.5 mi long concrete breakwaters border the existing harbor's 110 acres of water. To the harbor's west is the city. To protect against wave attacks, engineers designed modifications to the breakwaters that were already there and built a new stone berm breakwater that extends south from the eastern tip of the existing north breakwater to narrow the old 450 ft harbor entrance down to 200 ft. Departing from conventional breakwater design, engineers used a unique stone berm concept to modify the old north and south breakwaters and the new entrance breakwaters. The harbor improvements should be completed by the end of 1987. Racine's revitalized business district has won over 26 new retailers in the last two years, suggesting that the 1,000 boaters expected every weekend once the harbor is completed won't be the only out-of-towners to enjoy the renovated harbor. (Alexander-PTT)
W88-05128

**TUNNEL SAVED BY FLYASH,**
Neyer, Tiseo and Hindo Ltd., Detroit, MI.
K. M. Swaffar, and H. R. Price.
Civil Engineering CEWRA9, Vol. 57, No. 9, p 68-70, September 1987.

Descriptors: *Construction, *Engineering, *Tunnels, *Flyash, *Concrete, Water conveyance, Grouting, Repair.

Detroit's Northeast Raw Water Tunnel served well for more than three decades until last year. Then ground surface settlement above the tunnel, which is 90 ft deep and has an inside diameter of 10 ft, indicated potential tunnel distress in several areas. In one 180 ft long stretch, inspectors discovered a 15 cu yd silt boil on the tunnel bottom. They also found that the tunnel had subsided 18 in. On the walls were several diagonal cracks radiating from the center of the distressed area. The tunnel was promptly refilled with water to minimize inward flow of soil and groundwater. Underground work was performed 24 hours a day, 7 days a week, and the entire project completed in 63 days. To gain access, two shafts were excavated, one on each side of the distressed area and about 1,000 ft apart. One aspect of the remedial work is thought to be unique: a flyash-cement mix was used to fill and temporarily support the endangered section until the voids outside it were grouted. The soil/structure was thus self-supporting once again. The final step in the repair was to encase the ribs in shotcrete. The shotcrete line was designed to resist full overburden pressure, by modeling the existing liner as a rock mass. The shotcrete reduced the tunnel's inside diameter from 10 ft to about 8 1/2. Had the distressed area not been repaired the tunnel almost certainly would have failed, and with catastrophic results. (Alexander-PTT)
W88-05129

**HISTORY OF WATER IN THE AMERICAN WEST: JOHN S. EASTWOOD AND 'THE ULTIMATE DAM' (1908-1924),**
Pennsylvania Univ., Philadelphia. Dept. of American Civilization.
D. C. Jackson.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8703217. Ph.D Dissertation, 1986. 877 p, 164 fig, 383 ref, 2 append.

Descriptors: *Multiple arch dams, *Dam construction, *Construction methods, *Water storage, *Concrete construction, *History, Concrete dams, Reinforced concrete, Water resources development, Dam design, Dam stability, Dam failure, Damsites, Hydroelectric power, Mathematical analysis.

The work of John S. Eastwood in the building and promoting of reinforced concrete multiple arch dams in the West during the early 20th century is evaluated. The multiple arch dam offered a means of storing water that was much less expensive than any other type of comparable technology. The dams were cheaper because they significantly reduced the amount of concrete required to hold back a given height of water. Through these reductions, a means was provided to develop water resources that would remain unattractive if more traditional, and expensive, dam technologies were to be used. An overview of western water history is given, along with a history of dams built prior to the early 20th century. The multiple arch dam is also discussed in relation to hydroelectricity, structural art, mathematical computations, and its status after Eastwood's death. (Cremmins-AEPCO)
W88-05205

**WATER DISTRICT'S RECOVERY FROM STORM DAMAGE,**
San Lorenzo Valley Water District, Boulder Creek, CA.
J. A. Evensen.
Public Works PUWOAH, Vol. 118, No. 10, p 71-74, October 1987.

Descriptors: *Water distribution, *Hydraulic structures, *Pipelines, *Flood damage, *Maintenance, *Storms, *Damage, San Lorenzo Valley Water District, California, Water mains, Landslides, Polyethylene, Plastics.

The San Lorenzo Valley was declared a Federal Disaster Area after severe winter storms in 1982 and 1983 caused extensive damage to the water district. Temporary emergency repairs included installation of aluminum irrigation piping to provide raw water from a new diversion. Rediscovered during the emergency repairs was an old wooden flume trail dating to the early 1900s. The trail became the new route for a diversion structure. Prison labor was used to clear log jams and debris at little cost to the District. Since the route for the transmission mains snaked along a mountain slope in an area of no roads, a lightweight, high density polyethylene pipe, Driscopipe, was chosen. Pipe qualities pertinent to this project were cost-effective butt fusion without couplings, ability to be cold bent to a radius of 20-40 times the pipe diameter, ability to be installed either above or below ground, and nonbreakage if the water freezes. Thermal expansion and contraction were considered in installation. Helicopters were used extensively to deliver pipe and equipment. The project was finished in 8 months of work over two construction seasons. A severe winter storm in February 1986 did not damage the surface water diversion structures, but a landslide in an inaccessible area damaged the transmission line, burying 250 ft under 30 ft of debris and cutting off the water flow. The buried line was abandoned and new Driscopipe installed across the top of the slide. (Cassar-PTT)
W88-05345

**ELASTO-PLASTIC SEISMIC RESPONSE OF 3-D EARTH DAMS: THEORY,**
University of Southern California, Los Angeles. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W88-05371

**ELASTO-PLASTIC SEISMIC RESPONSE OF 3-D EARTH DAMS: APPLICATION,**
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W88-05372

**EVALUATING PORE PRESSURE IN EMBANKMENT DAMS,**
Motor-Columbus Ingenieurunternehmung A.G., Baden (Switzerland).
For primary bibliographic entry see Field 8D.
W88-05397

**SEALING WELL CASING: AN IDEA WHOSE TIME HAS COME,**
For primary bibliographic entry see Field 5G.
W88-05549

**TRIBUTARY RESPONSE TO LOCAL BASE LEVEL LOWERING BELOW A DAM,**
Colorado State Univ., Fort Collins. Dept. of Earth Resources.
For primary bibliographic entry see Field 2J.
W88-05550

**VIBRATIONS IN PENSTOCKS,**
Bharat Heavy Electricals Ltd., Hyderabad (India).
S. K. Bhave, C. L. Acharekar, C. B. N. Murthy, and S. K. Goyal.
International Water Power and Dam Construction IWPCDM, Vol. 39, No. 11, p 41-43, November 1987. 8 fig, 2 tab, 5 ref.

Descriptors: *Penstocks, *Vibrations, *Hydraulic structures, Case studies, Fundamental exciting frequencies, India, Pipes, Powerplants, Pressure waves, Waves, Ring stiffeners.

In spite of the lack of international standards for the limits of penstock vibration, potentially dangerous vibrations can be recognized although their sources cannot always be found or eliminated. Detailed analysis is required to find the fundamental exciting frequency to help identify the exciting source. A case study of penstock vibration at an Indian hydro powerplant is presented. Severe vibrations with an amplitude of 5-6 millimeters were observed on each of the penstocks of a 3 x 4.8 MW hydropower station where Francis turbines operate under a 38 meter head with a rotation speed of 333.3 revolutions/minute. The vibration and noise spectrum analyses that were carried out to determine the exact nature of the problem are detailed. In this case, the penstock vibrations were caused by self-excited pressure waves. In order to eliminate them, either a change in length and/or diameter of the penstocks, or interconnection of the penstocks would be required; neither was considered feasible. However, when the penstocks were reinforced with ring stiffeners to change their natural frequency, the vibrational problems were eliminated. (Wood-PTT)
W88-05582

**CONCRETE EXPANSION AT THE RIHAND DAM, INDIA,**
For primary bibliographic entry see Field 8F.
W88-05583

**INTERFACE SMEARED CRACK MODEL ANALYSIS OF CONCRETE DAMS IN EARTHQUAKES,**
Military Academy, West Point, NY. Dept. of Engineering.
For primary bibliographic entry see Field 8F.
W88-05627

**EFFECTS OF UNCERTAINTIES ON OPTIMAL RISK-BASED DESIGN OF HYDRAULIC STRUCTURES,**
Wyoming Water Research Center, Laramie.
For primary bibliographic entry see Field 6A.
W88-05643

**HYDRAULIC MODEL STUDIES OF UPPER STILLWATER DAM STEPPED SPILLWAY AND OUTLET WORKS,**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
For primary bibliographic entry see Field 8B.
W88-05694

**DYNAMIC EFFECTIVE STRESS FINITE ELEMENT ANALYSIS OF DAMS SUBJECTED TO LIQUEFACTION,**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
D. W. Harris.
Available from the National Technical Information Service, Springfield, VA. 22161. Bureau of Reclamation Report No. REC-ERC-86-4, December 1986. 45 p, 39 fig, 9 tab, 24 ref, 2 append.

Descriptors: *Stress, *Hydraulic structures, *Dams, Water pressure, Embankments, Model studies, Interstitial water, Mathematical studies, Soil water, Algorithms, Earthquake engineering.

The demand for safe facilities, especially those of great sensitivity and importance such as large embankment dams, nuclear powerplants, and offshore structures, has affirmed the need for improved analysis tools for evaluating their load-deformation responses and strength behavior, especially in earthquake-prone regions. The dynamic stress-strain, strength, and pore water pressure behavior of water-saturated soils in embankment dams and their foundations is highly nonlinear and quite difficult to model in a realistic manner. This report presents a simplified nonlinear finite element analysis technique that incorporates many of the important features of more rigorous procedures, yet requires input parameters that can be obtained from standard laboratory tests. Thus, it can be applied to predict the complex load-deformation and pore water pressure behavior of large dams. Analyses of established field cases show that the technique is feasible as a working tool. The analysis algorithm is based on an uncoupled relationship between soil skeleton deformations and pore water pressure as opposed to the coupled equations used in Biot-analysis. Comparisons between analytical predictions and laboratory and field experience show that the procedure is quite satisfactory. (Author's abstract)
W88-05695

**HURRICANE PROTECTION STRUCTURE FOR LONDON AVENUE OUTFALL CANAL, LAKE PONTCHARTRAIN, NEW ORLEANS, LOUISIANA. HYDRAULIC MODEL INVESTIGATION,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W88-05699

**STANDARD MODEL DESIGNS FOR RURAL WATER SUPPLIES.**
World Health Organization, Copenhagen (Denmark). Regional Office for Europe.
World Health Organization, Copenhagen, Denmark. 1986. 235 p, 136 fig, 12 tab.

Descriptors: *Model studies, *Water conveyance, *Rural areas, *Water management, *Design standards, *Water demand, Hydraulic design, Flow profiles, Water storage, Wells, Pumps, Water quality, Guidelines, Water supply, Czechoslovakia, Eastern Europe.

The design for a new water supply system must be hydraulically and structurally sound as well as financially feasible. World Health Organization has previously provided guidance on a range of designs for engineering components useful in rural water supplies. The standard model design approach presents, in easily interpreted forms, a series of designs for the different units in a water supply system; these can be applied and combined in different arrangements, in order to cover as wide a range of situations as possible. The designs are intended to be used by smaller water enterprises or municipalities to prepare their own schemes with the maximum use of their own engineering and technical capabilities. This approach also has the advantage of standardizing the equipment used within an area, region or district. This facilitates its operation, and maintains a certain design standard that would be impossible if each community prepared designs to satisfy its own requirements. Although this publication is intended to present one approach to the development of standard model designs for water supply, some basic information on the Socialist Autonomous Province of Kosovo (Czechoslovakia) is included to show the general context within which the work was undertaken, and where the case studies occur. Basic design criteria for these models must consider: (1) water demand; (2) water pressure; (3) water flows; (4) storage capacity; and (5) water quality. Standard model designs such as spring intake structures, bored deep wells, dug wells, pumping stations, aeration stations, and water main ancillary chambers, are presented, along with the application of standard model designs to 12 communities in Eastern Europe. (Lantz-PTT)
W88-05702

**NONLINEAR RESPONSE OF CONCRETE GRAVITY DAMS TO STRONG EARTHQUAKE-INDUCED GROUND MOTION,**
JAYCOR, Vicksburg, MS.
P. F. Mlakar.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A181 616. Price codes: A04 in paper copy, A01 in microfiche. Technical Report No. SL-87-7, March 1987. Final Report. 72 p, 24 fig, 6 tab, 31 ref. DOA Contract No. DACW39-85-M-4964.

Descriptors: *Concrete dams, *Earthquake engineering, *Cracks, Finite element method, Hydraulic structures, Mathematical studies, Seismic motion, Dams.

An investigation of the behavior of concrete gravity dams subjected to earthquake motions of sufficient strength to induce cracking, is documented. Nonlinear, dynamic, finite element analyses of three dams subjected to the Parkfield earthquake motion are conducted with the ADINA84 code. In the analyses the essential characteristics of static preloading, bidirectional seismic motion, dynamic

concrete cracking, and hydrodynamic interaction are modeled. The results show that cracked zones can propagate through the cross sections at various elevations. When excited by an earthquake motion of sufficient strength to initiate cracking, the three dams considered cracked completely through their cross sections. In some cases, this cracking progressed through stable stages and in others, it was virtually instantaneous. The cracking through the dam cross sections occurred at the base, at the elevation of downstream slope change, and at a lower elevation. The shortest structure considered cracked through its base while the taller ones cracked through the upper elevations. A recently published procedure conservatively evaluated the safety of the four cases considered. However, in two cases the simplified analysis procedure incorrectly located the elevation at which cracking occurs through the cross section. The sliding block analysis is a rational basis to estimate the permanent relative displacements along cracked planes through a dam cross section. (Lantz-PTT)
W88-05755

**RECOMMENDATIONS: LOAD TRANSFER CRITERIA FOR PILES IN CLAY,**
Toledo Univ., OH. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8D.
W88-05757

**IN SITU REPAIR OF DETERIORATED CONCRETE IN HYDRAULIC STRUCTURES LABORATORY STUDY,**
Brookhaven National Lab., Upton, NY. Process Sciences Div.
For primary bibliographic entry see Field 8F.
W88-05758

**CONSTRUCTION OF DRILLED PIER FOUNDATIONS,**
D. M. Greer, and W. S. Gardner.
John Wiley and Sons, New York, NY. 1986. 246 p.

Descriptors: *Concrete construction, *Drilled piers, *Construction, *Foundations, *Piers, Structural engineering, Caissons, Hydraulic structures, Construction methods, Excavation, Trenches, Drill holes.

This book, for contractors, engineers, architects, and developers, discusses the equipment and techniques involved in the construction of cast-in-place concrete foundations for which the excavation is made by an earth- or rock-boring machine. Such a foundation element, primarily used for the support of structures, is variously called a 'drilled pier,' a 'drilled caisson,' a 'drilled shaft,' or a 'large-diameter bored pile'. The type of drilled pier or caisson is often identified by the prefixes 'straight shaft,' or 'belled' or 'underreamed,' denoting respectively a constant-diameter and an enlarged-base shaft. Similarly, the term 'socketed' denotes a shaft drilled into rock to form a 'rock socket' which provides the primary resistance to the applied load. There are other types of large-diameter drilled holes in underground construction, in addition to the installation of foundations for structures, which are important enough to merit consideration in a book of this sort. Some of these are: very large diameter drilled holes for access shafts, missile silos, mineral exploration, and so on; slanted or battered holes for tieback anchors, drainage, or other uses (including batter piles); retaining walls and bracing for excavations (both tieback and cantilevered types); slurry trench construction (for seepage cutoff or for load-bearing walls); and landslide stabilization piers and drains. The book does not include consideration of driven piles, drilled-in piles (augered piles), 'displacement caissons,' or 'pressure-injected footings' (Franki piles). Nor does it cover drilled or mole-excavated tunnels. It deals only with installations in large-diameter machine-drilled (or bored) holes which have had all the soil removed (and usually, but not always, all the water). (Lantz-PTT)
W88-05783

**FOUNDATION DESIGN AND CONSTRUCTION,**
M. J. Tomlinson.
Longman Scientific and Technical, Essex, England. 1986. 842 p.

Descriptors: *Foundations, *Design standards, *Construction, Site selection, Soil mechanics, Geohydrology, Piers, Caissons, Piles, Cofferdams, Groundwater, Earthquakes, Deterioration, Structural engineering, Hydraulic engineering.

This book provides a manual of foundation design and construction methods for the practicing engineer, and is not intended to be a textbook on soil mechanics. However, it does include examples of the application of this science to foundation engineering. This fifth edition contains new material on methods of calculating the bearing capacity and settlement of foundations on rocks has been included as well as information on the application of computer-based techniques to foundation engineering. Chapter topics are: site investigations and soil mechanics; general principles of foundation design; foundation design in relation to ground movements; spread foundations, buoyancy rafts and basements (box foundations); pier and caisson foundations; piled foundations; foundation construction; cofferdams; geotechnical processes; shoring and underpinning; and protection of foundation structures against attack by soils and groundwater. (Lantz-PTT)
W88-05804

**GALLIPOLIS LOCK INTAKE VORTEX STUDY, OHIO RIVER: HYDRAULIC MODEL INVESTIGATION,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W88-05855

**WAVE TRANSMISSION CHARACTERISTICS OF VARIOUS FLOATING AND BOTTOM-FIXED RUBBER-TIRE BREAKWATERS IN SHALLOW WATER: EXPERIMENTAL MODEL INVESTIGATION,**
Coastal Engineering Research Center, Vicksburg, MS.
For primary bibliographic entry see Field 8B.
W88-05857

**PROCEDURES AND DEVICES FOR UNDERWATER CLEANING OF CIVIL WORKS STRUCTURES,**
Naval Civil Engineering Lab., Port Hueneme, CA.
C. A. Keeney.
Available from the National Technical Information Service, Springfield, VA. 22161 as ADA-188814. Price codes: A04 in paper copy; A01 in microfiche. Technical Report REMR-CS-8, November 1987. Final Report. 52 p, 20 fig, 2 tab, 16 ref, append.

Descriptors: *Hydraulic structures, *Maintenance, *Underwater cleaning, *Cleaning, Scrapers, Jets, Nozzles, Dredges, Air lifts, Performance evaluation, Comparison studies, Underwater.

Civil works structures must be continually evaluated for structural safety, stability, and operational adequacy. Proper inspection and evaluation of them to identify deficiencies will usually require some type of cleaning of the structure. A wide variety of underwater cleaning tools and methodologies have been developed and are currently in use in the off-shore oil industry and by the U.S. Navy. These tools range from hand-held scrapers to powered tools and high-pressure waterjets. Several tools have been specifically designed for removal of underwater debris. These tools include jet educators, dredges, and air lifts. This report summarizes underwater cleaning procedures and devices that are appropriate for use on civil works structures. The application, advantages, disadvantages, and operation of each type of equipment are discussed, along with recommendations for those tools best suited for specific conditions. (Author's abstract)
W88-05859

**LIFT GATE FOR LOCKPORT LOCK ILLINOIS WATERWAY: HYDRAULIC MODEL INVESTIGATION,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8C.
W88-05914

## 8B. Hydraulics

**EFFECTS OF NONLEVEL PLACEMENT ON ACCURACY OF LONG-THROATED FLUMES,**
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 7B.
W88-05144

**ANALYTICAL SOLUTION OF SIMPLIFIED SURGE FLOW EQUATIONS,**
Technische Univ. Muenchen (Germany, F.R.). Dept. of Waterworks and Water Management.
For primary bibliographic entry see Field 2E.
W88-05146

**VELOCITY HEAD CONSIDERATIONS FOR TRICKLE LATERALS,**
Arizona Univ., Tucson. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W88-05147

**FLOW THROUGH SIDE SLOTS,**
Detroit Water and Sewerage Dept., MI.
M. A. Gill.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 1047-1057, October 1987. 5 fig, 1 tab, 13 ref.

Descriptors: *Spatially varied flow, *Open-channel flow, *Varied flow, *Channels, *Side slots, *Hydrodynamics, *Head loss, *Model studies, Flow, Mathematical studies, Sewers, Equations, Friction.

Theoretical analysis of flow through side slots is presented as a special case of spatially varied flow. Frictional head loss in the parent channel over the length of the slot is ignored. The channel is also assumed to have a negligible slope. Two flow situations are analyzed: free-surface flow in the parent channel and pressure flow. Simple algebraic solutions are obtained for nearly frictionless flows and nearly horizontal channels. These simplifications are valid for relatively short side slots (as in sewers). Application of the given solutions is illustrated through three numerical examples. (Author's abstract)
W88-05165

**RESIDENCE TIME DISTRIBUTIONS OF SHALLOW BASINS,**
Vanderbilt Univ., Nashville, TN. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5F.
W88-05183

**RISK MODEL FOR STORM SEWERS WITH SUBMERGED OUTLETS,**
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
A. O. Akan.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 6, p 1376-1384, December 1987. 2 fig, 14 ref.

Descriptors: *Risk analysis, *Rainfall-runoff relationships, *Storm sewers, *Model studies, *Submerged outlets, Runoff, Rainfall, Mathematical studies, Prediction, Equations, Estimating.

The capacity of a storm sewer system with a submerged outlet is affected by the downstream boundary condition, i.e., by the water level submerging the system outlet. Thus, uncertainties resulting from the randomness of the downstream water level and the rainfall events exist in the

design of storm sewer systems with submerged outlets. A dynamic risk model is proposed for storm sewer systems with submerged outlets. The model considers hydrologic uncertainties as well as those resulting from the randomness of the downstream water level submerging the system outlet. The model can be applied to calculate the composite hydrologic/hydraulic risk for all the sewers affected by the condition of the outlet in a sequential manner, starting from the one closest to the outlet and proceeding systematically in the upstream direction. In the example used here, which involved only a single sewer and rather simple probability density functions, the composite risk was consistently higher than the hydrologic risk. The difference could be attributed to the uncertainties in downstream boundary conditions, which are taken into account only when calculating the composite risk. (Alexander-PTT)
W88-05187

**DIRECT THEORY FOR WAVES APPROACHING A BEACH,**
California Univ., Berkeley. Dept. of Naval Architecture and Offshore Engineering.
J. J. Shields.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8624936. Ph.D Dissertation, 1986. 131 p, 27 fig, 1 tab, 59 ref, 2 append.

Descriptors: *Wave action, *Wave propagation, *Shoals, *Shallow water, *Numerical analysis, Mathematical equations, Flow discharge, Beaches, Solitary waves, Gravity waves.

A direct theory for inviscid shallow-water flow was applied to the problem of shoaling water waves. A version of the general direct theory for unsteady, inviscid flow was derived. Equations to recover those of Green and Naghdi by an algebraic transformation were derived in a straightforward application of a variational procedure called 'the method for reduction of ordinary differential equations' due to Kantorovich. A coordinate transformation that maps the bounding surfaces of the physical fluid to coordinate planes in model spaces was introduced, resulting in significant simplifications of the general equations. The problem of steady, two-dimensional gravity waves over a horizontal bottom was studied. The direct theory was applied to the problem of wave shoaling. The theory was found to be a very powerful approximate method for shallow-water waves, and for the problem of wave shoaling in particular. Advantages in accuracy relative to perturbation theories were demonstrated. The theory appears to converge faster and includes physics wholly absent in comparable low-order approximations. Steady-state analysis indicates that the direct theory is valid for a much broader range of relative depth; at the third level of approximation this encompasses all depths for which the bottom has an effect. A drawback of the theory is the extreme algebraic complexity of the equations for higher-order approximations. (Cremmins-AEPCO)
W88-05217

**STABILITY LIMITS OF HYDROELECTRIC POWER PLANTS,**
Instituto Costarricense de Electricidad, San Jose.
For primary bibliographic entry see Field 8C.
W88-05374

**SPILLWAY CHUTE AERATION,**
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
P. Rutschmann, and P. Volkart.
International Water Power and Dam Construction IWPCDM, Vol. 40, No. 1, p 10-15, January 1988. 7 fig, 11 ref.

Descriptors: *Spillways, *Spillway aeration, *Cavitation, *Hydraulics, *Aeration, Air entrainment, Chutes, Mathematical equations, Mathematical studies, Model studies, Pumps, Hydraulic design, Flow characteristics.

Model and prototype measurements of aeration devices installed to prevent cavitation erosion in high velocity spillway flows have been published by various authors. However, the subpressure variation under the jet has often been neglected in the calculation of air entrainment because of the lack of adequate theory. Especially for physical models, which can reproduce only part of the width of the prototype chute, this simplification can be misleading. Therefore, the translation of model to prototype data has often been faulty. A theory about the subpressure variation is presented and the influence of the supply duct arrangement on air entrainment is demonstrated. (Author's abstract)
W88-05395

**DISCHARGE CHARACTERISTICS OF GATED STANDARD SPILLWAYS,**
Ecole Polytechnique Federale de Lausanne (Switzerland). Chaire de Constructions Hydraulics.
W. H. Hager.
International Water Power and Dam Construction IWPCDM, Vol. 40, No. 1, p 15-16, 21-26, January 1988. 9 fig, 5 ref, append.

Descriptors: *Spillway gates, *Hydraulics, *Flow characteristics, *Flow discharge, Spillways, Mathematical equations, Mathematical studies, Model studies, Gates, Hydraulic design, Hydraulic properties, Discharge equations.

The discharge equation for flow over a gated standard spillway, currently determined according to a method proposed by the US Army Corps of Engineers, is modified. Based on various model tests, a simpler and more general relationship is presented. Although the geometrical configuration and the various flow parameters require a complex computation of the governing flow features, the final result is quite simple to apply. The effects on discharge of the significant quantities, such as the position of the gate trunnion, the gate radius, the spillway geometry and the head on it, are accounted for in the proposed discharge relationship. The main flow features encountered on gated spillways are discussed. (Author's abstract)
W88-05396

**FLUID MECHANICS OF FRACTURE AND OTHER JUNCTIONS,**
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
For primary bibliographic entry see Field 5B.
W88-05438

**MODELING TIDAL POWER,**
For primary bibliographic entry see Field 6G.
W88-05500

**MODELING SOLUTE TRANSPORT USING QUICK SCHEME,**
Bradford Univ. (England). Dept. of Civil Engineering and Structural Engineering.
For primary bibliographic entry see Field 5F.
W88-05507

**HYDRAULICS OF HORSESHOE AND ARCH SEWERS,**
Detroit Water and Sewerage Dept., MI.
M. A. Gill.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 114, No. 1, p 179-189, February 1988. 4 fig, 6 tab, 7 ref.

Descriptors: *Sewers, *Sewer hydraulics, *Hydraulics, Horseshoe sewers, Arch sewers, Flow characteristics, Hydraulic properties, Hydraulic tables, Mathematical equations, Uniform flow, Critical flow, Flow, Storm sewers, Storm runoff.

Horseshoe and arch sewers have been constructed in the United States for the transportation of large flow rates of combined storm runoff. Satisfactory hydraulic analyses could previously only be performed for circular sewers with the information available in hydraulics and sewerage textbooks or for the relatively easily analyzed rectangular and square sewers. The collection of hydraulic tables previously published for egg sewers are extended to include tables for analyzing the horseshoe and arch sewers. Hydraulic tables are computed for four different sewers, two horseshoe and two arch-shaped, and are used for solving the hydraulic problems presented in several numerical examples. Approximate formulae are also given for the computation of uniform and critical flows. (Wood-PTT)
W88-05518

**HYDRAULIC MODEL STUDIES OF UPPER STILLWATER DAM STEPPED SPILLWAY AND OUTLET WORKS,**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
K. L. Houston.
Available from the National Technical Information Service, Springfield, VA. 22161. Bureau of Reclamation Report No. REC-ERC-87-6, October 1987. 51 p, 30 fig, 4 tab, 3 ref, append.

Descriptors: *Hydraulic models, *Upper Stillwater Dam, *Energy dissipation, *Dams, *Design standards, *Spillways, Hydraulic structures, Model studies, Flow velocity, Energy, Stilling basins, Flow profiles, Outlets, Concrete construction.

Hydraulic model studies were made to aid in the design of a stepped spillway. Stepped spillways, economically constructed of slip-formed conventional concrete, may be used where the stilling basin size must be limited. An outlet works stilling basin, designed for submerged operation of a 14-inch jet-flow gate, was also studied. The results of the stepped spillway model study indicated that the crest shape is vital to efficient hydraulic operation and that the energy contained in the jet is minimal because of the tumbling action induced by the steps. The maximum velocity measured on the face of the 202-foot-high spillway near the toe was about 41 ft/s. Energy dissipation was approximately 75% greater than it would be for a smooth conventional spillway. This energy dissipation permitted the stilling basin length to be reduced from 200 to 30 ft. Impact and subatmospheric pressures on the steps of the spillway face were also investigated. The outlet works stilling basin was based on operation of the submerged 14-inch jet-flow gate under a maximum head of 207.5 ft and a discharge of 29 cu ft/s. The small, boxlike stilling basin resembles the type VI basin described in Bureau of Reclamation Monograph No. 25. The stilling basin operation is independent of the tailwater. Final dimensions of the basin were 17.5 ft long by 9 ft wide by 19 ft deep with a 7-ft high end sill. Impact pressures, wave heights, and debris handling were investigated with the model. (Author's abstract)
W88-05694

**HURRICANE PROTECTION STRUCTURE FOR LONDON AVENUE OUTFALL CANAL, LAKE PONTCHARTRAIN, NEW ORLEANS, LOUISIANA. HYDRAULIC MODEL INVESTIGATION,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
J. R. Leech.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report No. HL-87-16, December 1987. Final Report. 157 p, 19 fig, 3 tab, 4 photos, 62 plates, append.

Descriptors: *Hurricanes, *Flood protection, *Outfalls, *Lake Pontchartrain, *New Orleans, Butterfly gates, Louisiana, Hydraulic structures, Hydraulic models, Gates, Flow control, Flood plain management, Canals, Flood discharge, Storm runoff.

A 1:20-scale physical model investigation was conducted to give a three-dimensional analysis of the hydraulic performance of a unique vertical butterfly-gated structure, measure the torque on each gate shaft due to incoming and outgoing flows, and evaluate the effects of wave action on the gates. The model was also used to align the canal to provide a more uniform flow distribution through the structure and measure the water-surface differentials across the structure. Model tests indicated that the original design did not perform as intend-

ed; therefore, a solution was obtained by modifying the geometry of the canal and gates by trial and error. The recommended crescent gate design performed satisfactorily for anticipated incoming and outgoing flows. Storm waves were measured along the reach of the canal from the lake to the structure to determine the maximum wave heights propagating in the canal. The model also indicated that the torque on each gate shaft decreased with waves superimposed during pumping operations and increased with waves superimposed during storm surges. The results of the torque measurements are presented to give design information for sizing the dampening device which operates as a shock absorber, the vertical shafts, operating machinery, and structural components. (Author's abstract)
W88-05699

**EVALUATION OF VERTICAL MOTION SENSORS FOR POTENTIAL APPLICATION TO HEAVE CORRECTION IN CORPS HYDROGRAPHIC SURVEYS,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 7B.
W88-05708

**WALNUT CREEK FLOOD-CONTROL PROJECT, CONTRA COSTA COUNTY, CALIFORNIA,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
W. G. Davis.
Available from the National Technical Information Service, Springfield, VA. 22161. Hydraulic Model Investigation. Technical Report No. HL-87-14, October 1987. Final Report. 64 p, 2 fig, 22 photos, 25 plates.

Descriptors: *Channel flow, *California, *Flood control, *Hydraulic models, *Walnut Creek, *Confluent streams, Stream flow, Flow profiles, Mannings equation, Roughness coefficient, Model studies, Channel improvement, Mathematical studies, Slopes, Channels.

Tests were conducted on a 1:25-scale model of the Walnut Creek channel to determine the adequacy of proposed channel improvements for the Walnut Creek channel, the San Ramon Bypass Channel, and their junction. The slopes of the model were initially adjusted to produce an energy gradient resulting from a Manning's n roughness factor of 0.012 in the prototype. Unsatisfactory flow conditions were observed in the Walnut Creek channel upstream from the junction due to entrance conditions into the high-velocity channel. A wall was installed which bridged the access ramp and provided satisfactory flow conditions in the portion of Walnut Creek upstream from the junction. Flow exceeded the wall heights at several points downstream from the San Ramon-Walnut Creek junction for both design flows with their maximum concurrent flows. A 40 ft long divider extension installed at the junction greatly improved flow conditions in the channel downstream and eliminated overtopping of the channel walls. The slopes of the high-velocity channel were adjusted to reproduce the energy gradient resulting from a Manning's n roughness factor of 0.014 in the prototype. For both design flow conditions, overtopping of the wall heights was observed in the Walnut Creek channel. The width of the San Ramon Bypass Channel was reduced by 1 ft to 23 ft just upstream of the junction and the channel alignment was improved at the junction; the slope of the Walnut Creek channel was increased to 0.005 ft/ft downstream from the junction with this slope maintained in the San Ramon Bypass Channel upstream from the junction to sta 548+98; and the slope of the Walnut Creek channel upstream from the junction was increased to 0.0185 ft/ft extending to sta 584+50. These modifications provided satisfactory flow conditions for both design flows in the high-velocity channels. However, by steepening the slopes in the Walnut Creek channel, the upstream elevation of the channel invert was increased 1.5 ft, which increased the upstream pool elevation to an undesirable level. When flow through the access ramp was blocked, channel efficiency was increased and a satisfactory pool elevation was achieved with the design flow in Walnut Creek. (Author's abstract)
W88-05709

**HYDRAULIC PROCESSES ON ALLUVIAL FANS,**
Nevada Univ. System, Las Vegas. Water Resources Center.
For primary bibliographic entry see Field 2J.
W88-05777

**DESIGN AND USE OF PRESSURE SEWER SYSTEMS,**
Thrasher Engineering, Rogers, AR.
For primary bibliographic entry see Field 5D.
W88-05854

**GALLIPOLIS LOCK INTAKE VORTEX STUDY, OHIO RIVER: HYDRAULIC MODEL INVESTIGATION,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
R. A. Davison.
Available from the National Technical Information Service, Springfield, VA. 22161 as ADA-188817. Price codes: A04 in paper copy; A01 in microfiche. Technical Report No. HL-87-17, December 1987. Final Report. 65 p, 4 fig, 2 tab, 18 photos, 24 plates.

Descriptors: *Gallipolis Lock, *Ohio River, *Vortices, *Hydraulic models, Model studies, Performance evaluation, Eddies, Flow patterns, Culverts, Intakes, Hydraulic structures, Locks, Canals, Navigation.

The existing Gallipolis Locks are located on the Ohio River at mile 279.2. Because of their location on an inside bend, the orientation for approach channels, velocity currents in the river, and the design of the approach walls, entry of downbound tows into the lock is hazardous and time consuming during periods of high flow. As a result of increasing traffic and tow sizes, these locks have become a serious problem to vessel movement along the Ohio River. Replacement locks will be constructed in the near future to alleviate these problems. Tests were conducted on a 1:25-scale model that reproduced 2,500 ft of the Ohio River beginning 188 ft upstream of the existing lock guide wall. Approximately 250 ft of the width of the river was reproduced. This model was used to evaluate the performance of the intake structures for the new locks. Two different alternate plans for the filling of the locks were tested. One plan consisted of filling the lock through long culverts extending from the river to the lock chamber. The other plan consisted of an intake canal extending from the river to the guide wall. Two intakes were located on the riverward side of the new lock approach wall, and one intake was located in the filling canal. Air-entraining vortices developed at the intake structure in both plans. The air-entraining vortices observed in both plans were eliminated by modification to the intake structure. (Author's abstract)
W88-05855

**WAVE TRANSMISSION CHARACTERISTICS OF VARIOUS FLOATING AND BOTTOM-FIXED RUBBER-TIRE BREAKWATERS IN SHALLOW WATER: EXPERIMENTAL MODEL INVESTIGATION,**
Coastal Engineering Research Center, Vicksburg, MS.
D. G. Markle, and M. A. Cialone.
Available from the National Technical Information Service, Springfield, VA. 22161 as ADA-187579. Price codes: A03 in paper copy; A01 in microfiche. Miscellaneous Paper CERC-87-8, September 1987. Final Report. 40 p, 1 fig, 6 tab, 15 plates, 9 ref, append.

Descriptors: *Wave action, *Breakwaters, *Shallow water, Hydraulic studies, Rubber tires, Hydraulic models, Waves, Model studies, Wave height.

A two-dimensional experimental model investigation was conducted at a scale of 1:4, model: prototype, to determine and compare the wave transmission characteristics of various floating and bottom-fixed, rubber-tire breakwater concepts when placed over or on mild bottom slope in shallow water and exposed to nonbreaking and breaking waves. Wave transmission characteristics of each concept as it corresponds to incident wave height, wave period, water depth, wave steepness, relative wave height, and relative depth are presented in both graphical and tabular form. The concepts are ranked from best to worst relative to the wave protection they appear to provide in a shallow-water wave environment. It was found that the concepts tested can be ranked from best to worst in regard to their overall ability to dissipate incident wave energy, as follows: (1) For concepts positioned on or over a 1V-on-55H (mild) bottom slope with their sea side in a 2.0-ft water depth and exposed to incident wave heights ranging from 0.5 to 1.8 ft for wave periods of 2.0, 4.0, 6.0, 8.0, and 10.0 sec: Concept 4, two rows of tires on cables, two tiers high, Concept 6, three bottom-fixed Goodyear modules, Concept 3, one row of tires on cables, two tiers high, Concept 5, three floating Goodyear modules, Concept 7, one bottom-fixed Goodyear module, Concept 2, tires on wooden pilings, No breakwater, and Concept 1, one floating Goodyear module; (2) For concepts positioned on or over a 1V-on-55H (mild) bottom slope with their sea side in a 4.0-ft water depth and exposed to incident wave heights ranging from 1.0 to 3.0 ft for wave periods of 2.0, 4.0, 6.0, 8.0, and 10.0 sec: Concept 9, two rows of tires on cables, three tiers high, Concept 8, one row of tires on cables, three tiers high, Concept 3, one row of tires on cables, two tiers high, Concept 5, three floating Goodyear modules, Concept 6, three bottom-fixed Goodyear modules, and no breakwater. (Lantz-PTT)
W88-05857

## 8C. Hydraulic Machinery

**POTENTIAL HYDROENERGY PRODUCTION BY OPTIMIZATION,**
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6D.
W88-05156

**HISTORY OF WATER IN THE AMERICAN WEST: JOHN S. EASTWOOD AND 'THE ULTIMATE DAM' (1908-1924),**
Pennsylvania Univ., Philadelphia. Dept. of American Civilization.
For primary bibliographic entry see Field 8A.
W88-05205

**FIELD PERFORMANCE OF CORRUGATED POLYETHYLENE PIPE,**
Ohio Dept. of Transportation, Columbus.
For primary bibliographic entry see Field 8G.
W88-05344

**INTAKE OPERATION FOR DEEP COOLING RESERVOIRS,**
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W88-05373

**STABILITY LIMITS OF HYDROELECTRIC POWER PLANTS,**
Instituto Costarricense de Electricidad, San Jose.
O. F. Jimenez, and M. H. Chaudhry.
Journal of Energy Engineering JFEED9, Vol. 113, No. 2, p 50-60, September 1987. 4 fig, 12 ref, Append.

Descriptors: *Hydraulic structures, *Hydraulics, *Pipes, *Elastic properties, *Hydroelectric plants, Electric powerplants, Powerplants, Water hammer, Pipe flow, Flow, Penstocks.

An analytical criterion for the stability of a single, isolated hydroelectric unit is derived, including the

effects of water hammer. The elasticity of the pipe walls and the compressibility of the water column were destabilizing influences on the operation of a hydroelectric powerplant. A single hydro-unit supplying a resistive, isolated load was considered. For systems having an Allievi parameter (p) of <2 the elastic effect was noticeable; for systems having a p value of <1, the effect was important and should be considered when studying the governing characteristics of high-head power plants. (Cassar-PTT)
W88-05374

**NON-SANITARY ENGINEERING FEATURES CAN HELP ENSURE A PLANT'S SUCCESS,**
Krishna Engineering Consultants, Inc., West Des Moines, IA.
For primary bibliographic entry see Field 5F.
W88-05557

**DON'T BOTHER WITH SECONDARY CLARIFIER DISTRIBUTED INLETS,**
Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.
For primary bibliographic entry see Field 5D.
W88-05564

**RECENT TRENDS IN THE DESIGN AND LAYOUT OF PELTON TURBINES,**
Norges Tekniske Hoegskole, Trondheim.
H. Brekke.
International Water Power and Dam Construction IWPCDM, Vol. 39, No. 11, p 13-16, November 1987. 6 fig, 8 ref.

Descriptors: *Turbines, *Pelton turbines, *Hydraulic machinery, *Hydraulic design, Norway, Design criteria, Design standards, Mathematical equations, Runners, Nozzles, Jets, Distributors.

The present generation of Pelton turbines was developed in the 1960s in Norway when the first plans for large Pelton units on the west coast of Norway were discussed. The main problems associated with high-head Pelton units include fatigue, cavitation, and sand erosion. The successful performance of a turbine depends on the design of the runner; the nozzle and distributor designs are also important for efficient jets with uniform energy distribution. A mathematical expression was derived to show that the largest units with the lowest number of jets should be chosen if sand erosion is expected. Design criteria are detailed and a brief description of a possible design of an 860 MW ultra high-head turbine is presented. (Wood-PTT)
W88-05579

**DEVELOPMENTS IN THE DESIGN OF KAPLAN TURBINES,**
Ljubljana Univ. (Yugoslavia). Faculty of Mechanical Engineering.
F. Schweiger, and J. Gregori.
International Water Power and Dam Construction IWPCDM, Vol. 39, No. 11, p 16-20, November 1987. 13 fig, 14 ref.

Descriptors: *Turbines, *Hydraulic machinery, *Kaplan turbines, Statistical analysis, Mathematical studies, Mathematical equations, Design standards, Regression analysis, Data interpretation.

Data were collected from manufacturers and other sources to provide a statistical evaluation of present trends in the development of Kaplan turbines. About 120 Kaplan turbine units were studied covering the majority of the manufacturers and allowing comparisons among different design methods. The information gathered permits quick, reliable estimation of basic Kaplan parameters; the regression curve data show limited scattering. The statistical curve of specific diameter vs specific speed gives the average value of the hydraulic and geometrical parameters and the results can be used with confidence. The graphs can be used as a statistical pointer to the future design of Kaplan turbines. Preliminary studies on small hydro units show very close resemblance to the data obtained on large units. (Wood-PTT)
W88-05580

**DESIGNING FRANCIS TURBINES: TRENDS IN THE LAST DECADE,**
Electroconsult, Milan (Italy).
A. Lugaresi, and A. Massa.
International Water Power and Dam Construction IWPCDM, Vol. 39, No. 11, p 23-28, November 1987. 12 fig, 1 tab, 1 ref.

Descriptors: *Francis turbines, *Turbines, *Hydraulic machinery, *Statistical analysis, Mathematical equations, Mathematical studies, Design standards, Design criteria, Regression analysis, Data interpretation, Specific speed, Cavitation coefficient, Cavitation.

Data from 120 Francis turbine units, including five small hydro machines, were supplied by manufacturers and evaluated using statistical methods. The scope of the data covers machines designed since 1974 and is limited to parameters, such as specific speed and cavitation coefficient, that influence the basic selection of the unit. The relationships detailed were calculated by linear regression with simplifications introduced when they allowed the derivation of a simpler formula without the introduction of significant errors. The results obtained are, therefore, accurate enough for preliminary design and layout purposes, and permit comparison of various options; the final selection of machines should be based on the complete operating diagram of the machine. (Wood-PTT)
W88-05581

**SUBMERSIBLE SEWAGE PUMPING SYSTEMS HANDBOOK.**
For primary bibliographic entry see Field 5D.
W88-05697

**LIFT GATE FOR LOCKPORT LOCK ILLINOIS WATERWAY: HYDRAULIC MODEL INVESTIGATION,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
D. R. Cooper.
Available from the National Technical Information Service, Springfield, VA. 22161 as ADA-188380. Price codes: A03 in paper copy; A01 in microfiche. Technical Report HL-87-15, October 1987. Final Report. 6 fig, 6 tab, 3 photos, 12 plates.

Descriptors: *Lift gates, *Locks, *Illinois waterway, *Hydraulic models, Hydraulic machinery, Hydraulic structures, Model studies, Gates, Hydraulic loading.

The guard lift gate for the Lockport Lock will be equipped to operate during emergency closure of the lock chamber. This involves operation under dynamic heads. A 1:24-scale section model of the lock chamber, guard and service gate sills, the guard gate, approach area, and lock chamber was used to study magnitude and frequency of the hydraulic forces acting on the lifting cables and the flow conditions over the gate. Tests indicated that the hydraulic load increased as the exposed gate height increased until the exposed gate height became approximately equal to 60% of the pool height. At this point, the hydraulic loads peaked and began to decrease with increasing exposed gate heights. This hydraulic model investigation yielded hydraulic loads less than the calculated hydraulic loads provided by the US Army Engineer District, Rock Island. Although some gate vibrations were indicated, they were random and small compared to the magnitude of the total load. (Author's abstract)
W88-05914

## 8D. Soil Mechanics

**SEISMIC RESPONSE OF DAM WITH SOIL-STRUCTURE INTERACTION,**
Geological Survey, Menlo Park, CA.
G. N. Bycroft, and P. N. Mork.
Journal of Engineering Mechanics (ASCE) JENMDT, Vol. 113, No. 9, p 1420-1428, September 1987. 13 fig, 12 ref.

Descriptors: *Dam foundations, *Earthquakes, *Seismic design, *Soil mechanics, Engineering, Dams, Design criteria.

An analytical solution to the response of a long trapezoidal-section dam on a foundation consisting of an elastic half-space and subjected to simulated earthquake motion was developed. An optimum seismic design is achieved when the cross section of the dam is triangular. The effect of soil structure interaction is to lower the strain occurring in the dam. A triangular cross section gives the minimum volume and thus, cost of the dam, while minimizing the base shear. It also distributes the shear up the height of the dam in a desirable fashion regardless of other engineering constraints determine the shear moduli and base-height ratio. Most dam designs do result in a small top width, partly because of the variation of water pressure with depth. Soil-structure interaction decreases the strains. It is assuring that the seismic design requirements considered here do not interfere with customary engineering practice. (Alexander-PTT)
W88-05127

**ELASTO-PLASTIC SEISMIC RESPONSE OF 3-D EARTH DAMS: THEORY,**
University of Southern California, Los Angeles. Dept. of Civil Engineering.
A. M. Abdel-Ghaffar, and A.-W. M. Elgamal.
Journal of Geotechnical Engineering JGENDZ, Vol. 113, No. 11, p 1293-1308, November 1987. 6 fig, 31 ref. NSF grant CEE-8120757.

Descriptors: *Hydraulic structures, *Dams, *Earth dams, *Seismic properties, *Earthquakes, Model studies, Mathematical models, Soil mechanics, Vibration, Cost analysis.

A simplified cost-effective analytical-numerical procedure is developed for the nonlinear hysteretic seismic analysis of three-dimensional (3-D) nonhomogeneous, one-zone earth dams. The procedure can be applied efficiently to problems of the nonlinear dynamic response of soil and/or soil-structure systems. The procedure is based on a Galerkin formulation of the 3-D equations of motion in which the solution is expanded using 3-D eigenmodes of the linearized 3-D problem. The linear mode shapes are obtained using low-strain elastic moduli and a variational energy approach utilizing both Hamilton's principle and the Rayleigh-Ritz method. The nonlinear approach is based on a model discretization of the spatial domain in which 3-D linear modes are coupled due to material nonlinearity. The dynamic constitutive behavior of the dam materials is modeled using the concept of multiyield surface incremental plasticity in which a purely kinematic hardening rule is adopted. Spatial integrations are performed using a numerical scheme in which Gaussian quadrature is adopted. The time integration of the resulting semidiscrete matrix equation is performed using the Newmark method. Finally, in the analysis, all three directional input ground motions are considered simultaneously; nonlinear dynamic transient solutions, including permanent deformations, can be obtained at modest computational expenses. (See also W88-05372) (Author's abstract)
W88-05371

**ELASTO-PLASTIC SEISMIC RESPONSE OF 3-D EARTH DAMS: APPLICATION,**
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Civil Engineering.
A.-W. M. Elgamal, and A. M. Abdel-Ghaffar.
Journal of Geotechnical Engineering JGENDZ, Vol. 113, No. 11, p 1309-1325, November 1987. 12 fig, 1 tab, 9 ref. NSF grant CEE81-20757.

Descriptors: *Dams, *Earth dams, *Algorithms, *Seismic properties, *Earthquakes, Model studies, Soil mechanics, Hydraulic structures, Mathematical models, Vibration, Santa Felicia Dam, California.

An analytical-numerical procedure was applied to compute the nonlinear response of an earth dam to a 3-D input strong motion with recorded maximum acceleration of 1.2 g in the upstream-downstream

direction. The dam used in the study was Santa Felicia Dam, California, a modern rolled-fill earth embankment, 275 ft high above bedrock, 30 ft wide at the crest, and 1275 ft maximum length. Special features of the nonlinear seismic response due to the very strong shaking were explored. The contribution of different modes to the response of the dam at different locations was revealed. Comprehensive comparisons were made with results obtained by a more elaborate nonlinear, 3-D, finite element analysis of the dam. The comparison indicates that the proposed simplified analysis method can be used to reliably estimate the entire time history of all response quantities and the resulting permanent deformations of earth dams subject to earthquakes. Computed results agreed reasonably well with those of the finite element analysis; further, the modal nonlinear procedure was found to be reasonably accurate and extremely efficient computationally. (See also W88-05371) (Cassar-PTT)
W88-05372

**EVALUATING PORE PRESSURE IN EMBANKMENT DAMS,**
Motor-Columbus Ingenieurunternehmung A.G., Baden (Switzerland).
R. Dungar.
International Water Power and Dam Construction IWPCDM, Vol. 40, No. 1, p 26-29, January 1988. 3 fig, 13 ref.

Descriptors: *Pore pressure, *Embankment dams, *Earth dams, *Dams, *Water pressure, Pores, Porous media, Mathematical equations, Mathematical studies, Model studies, Simulation, Porosity, Stress analysis, Stress, Conwap Dam, Philippines, Dam construction, Dam design, Computers.

Structural calculations of embankment dams and representation of construction materials with special emphasis on partial saturation conditions using the latest methods of computer simulation are described. It is shown that the pore-water suction pressure existing in partially saturated material, particularly those possessing a high clay or silty-clay content, is a fundamental property which must be included in the material model for adequate computer simulation. Inaccurate model results are obtained when this pressure is neglected, even under consolidated-drained triaxial test conditions; the pore suction produces an effective cohesion. Material parameters taken from the presented model simulation for the given silty clay, together with results from rockfill and filter materials, were used in an effective stress analysis of the Conwap dam in the Philippines. (Wood-PTT)
W88-05397

**SHAKE-PROOF DAMS,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.
W. Marcuson, and M. L. Silver.
Civil Engineering CEWRA9, Vol. 57, No. 12, p 44-47, December 1987. 1 fig.

Descriptors: *Soil mechanics, *Dam stability, *Dam failure, *Dam design, *Embankments, *Seismic properties, Foundation failure, Earth dams, Earthquakes, Liquefaction, Soil stability, Jackson Lake Dam, Wyoming, Lower San Fernando Dam, California, Pore pressure, Drainage.

Dams in seismic regions are being modified to strengthen them against future earthquake damage. About 650 of the 2,000 Federal dams are located in highly seismic areas, which are on the Pacific Coast and in Wyoming, Illinois, South Carolina, and Utah. Liquefaction is a phenomenon of excess soil water pressure which reduces the soil effective stress to near zero. It has caused numerous sand boils, slides, and instabilities. Fault movement and tectonic ground movements are often manifested as slides into the reservoir and failure of spillway or outlet works. Remedial action for a dam declared unsafe is classified as follows: (1) changing operational procedures; (2) in situ improvement; (3) changing the structure; and (4) controlling undesirable pore water pressures. Operational changes may include taking the dam out of service, relocating the downstream population, setting up a warning system, and lowering the reservoir level. In situ improvements reduce liquefaction by replacing unsatisfactory material, altering material properties, performing grouting or chemical stabilization, and compacting soil. Structural solutions include adding a berm to the downstream slope, increasing the freeboard, and building a new, adjacent embankment. Drainage control of undesirable pore pressures can be achieved by using relief wells, dewatering systems, drains, and groundwater controls such as ditches and plastic liners. (Cassar-PTT)
W88-05481

**GEOTECH IMPORT: DEEP SOIL MIXING,**
Geo-Con, Inc., Pittsburgh, PA.
B. H. Jasperse, and C. R. Ryan.
Civil Engineering CEWRA9, Vol. 57, No. 12, p 66-68, December 1987. 2 fig.

Descriptors: *Soil mechanics, *Dam stability, *Dam failure, *Embankments, *Seismic properties, Foundation failure, Earth dams, Earthquakes, Soil stability, Grouting, Liquefaction, Jackson Lake Dam, Wyoming, Deep soil mixing technique, Drilling.

The deep soil mixing technique is being used to stabilize the Jackson Lake Dam, Wyoming, which is subject to liquefaction in case of earthquake. The process mixes slurry deep into soils to improve the strength, bearing capacity, and impervious qualities without any excavation or removal. The stabilizing agent is a very fluid water-cement grout with a small amount of bentonite added. An auger penetrates the soil as the slurry is injected. The broken soil is lifted to the mixing paddles which blend the slurry and soil. Use of an auger of the proper diameter permits construction of columns of uniform size in any arrangement. They can be placed at great depths with no vibration and little noise. Other uses for deep soil mixing are construction of foundations, underwater soil stabilization, installation of cutoff walls to prevent contaminant migration, deep aeration for digestion of organic wastes, and stripping soil of volatile organics. (Cassar-PTT)
W88-05484

**MICROCAD: PUSHING THE LIMITS,**
For primary bibliographic entry see Field 8G.
W88-05487

**DYNAMIC EFFECTIVE STRESS FINITE ELEMENT ANALYSIS OF DAMS SUBJECTED TO LIQUEFACTION,**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
For primary bibliographic entry see Field 8A.
W88-05695

**RECOMMENDATIONS: LOAD TRANSFER CRITERIA FOR PILES IN CLAY,**
Toledo Univ., OH. Dept. of Civil Engineering.
A. G. Heydinger.
Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A181 713. Price codes: A04 in paper copy, A01 in microfiche. Technical Report ITL-87-1, January 1987. Final Report. 79 p, 38 fig, 6 tab, 63 ref, append. DOA Contract No. DACW39-84-M-2309.

Descriptors: *Clays, *Soil properties, *Piles, *Hydraulic structures, Axial loads, Rigid foundations, Mathematical studies, Instrumentation.

A comprehensive evaluation was made of load-transfer criteria for analysis of axially loaded piles in clay. The US Army Corps of Engineers installs thousands of piles each year in the construction of navigational and flood control structures. So that these structures will perform satisfactorily, not only must the capacity of the pile foundations be adequately determined but the load-deformation behavior of the foundation must also be predicted to allow an analysis of the structure for stresses and deformations. Various predictive methods for computing side resistance capacity and shear transfer versus vertical pile movement, f-z curves, for clay are presented. Parametric studies were conducted to determine the method that could best represent pile behavior. Instrumented pile loads were used to evaluate the performance of the methods under actual field conditions. Based on these investigations, procedures for determining side resistance and shear transfer versus vertical pile movement are recommended. (Author's abstract)
W88-05757

**SOLVING PROBLEMS IN SOIL MECHANICS,**
B. H. C. Sutton.
Longman Scientific and Technical, Essex, England. 1986. 234 p.

Descriptors: *Soil mechanics, *Mathematical studies, Soil water, Soil stability, Soil physics, Algorithms, Mathematical equations, Slope stability, Textbook.

The science of soil mechanics is discussed from basic principles through the more advanced aspects by the use of problems with detailed solutions. Topics covered include the physical and mechanical properties of soil, effects of water on soil, stability of slopes, the bearing capacity of soil and ways of classifying it and improving its properties. (Lantz-PTT)
W88-05779

**FOUNDATION DESIGN AND CONSTRUCTION,**
For primary bibliographic entry see Field 8A.
W88-05804

**RESULTS OF RESEARCH IN SAMPLING LOESSIAL SOIL FOR INPLACE UNIT WEIGHT DETERMINATIONS,**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
T. J. Casias.
Available from the National Technical Information Service, Springfield, VA. 22161 as PB88-119748. Price codes: A03 in paper copy; A01 in microfiche. Bureau of Reclamation Report No. REC-ERC-87-5, June 1987. 37 p, 17 fig, 12 tab, 8 ref, 2 append.

Descriptors: *Soil properties, *Loess, *Sampling, Soil water, Dry weight, In situ tests, Davis Creek, Hollow-stem auger, Geophysics, Nebraska.

An investigation program to evaluate methods of determining inplace dry unit weight in loessial soil was developed and initiated by various divisions of the Bureau of Reclamation. Two locations at the Davis Creek damsite and two locations along the Mirdan Canal (Nebraska) alignment were selected for testing. The investigation program involved continuous sampling with a 6-1/4 inch (15.9 cm) inside diamter hollow-stem auger sampler and continuous sampling with a 5-inch (13-cm) pus-tube sampler. Inplace dry unit weight and moisture content were determined on samples obtained by both drilling methods at approximately the same depth intervals. Recovery was computed for all samples. A gamma-gamma down-hole density tool was then used in each drill hole. Following completion of the geophysical down-hole unit weight testing, test pits were excavated at all four sites. Sand-cone and surface nuclear gauge tests were made at frequent intervals in all test pits. Block samples were also obtained at frequent intervals in each test pit. The sand-cone method was used as the standard for evaluating all inplace dry unit weight test data. Data from this investigation program provide trends produced by each sampling and testing method. There is some variation in the location and depth intervals of the samples tested. (Lantz-PTT)
W88-05858

## 8E. Rock Mechanics and Geology

**BOREHOLE COLOUR TV SYSTEMS FOR UNDERGROUND EXPLORATIONS,**

Electric Power Development Co. Ltd., Tokyo (Japan).
For primary bibliographic entry see Field 8G.
W88-05399

**CONCRETE-FACED ROCKFILL DAM: I. ASSESSMENT,**
J. L. Sherard, and J. B. Cooke.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 113, No. 10, p 1096-1112, October 1987. 2 fig, 1 tab, 41 ref.

Descriptors: *Rockfill dams, *Dam design, *Dams, *Rocks, Rock fill, Concrete-faced dams, Comparison studies, Dam stability, Earth dams, Earthquakes, Spillways.

The concrete-face rockfill dam (CFRD) is currently being used with increasing frequency throughout the world. It has substantial advantages over the earth-core rockfill dam, the common alternate dam type considered. The CFRD is considered to have high fundamental safety, especially against strong earthquake shaking, and to be appropriate for use for very high dams. Placing the rockfill embankment in stratified layers, with the larger rocks in the bottom of each layer, is desirable practice. Crest settlements are relatively low, and decrease in rate rapidly after the first few years. Static stability analyses are not used for CFRD design. It is believed safe and reasonable to build spillways over CFRDs. (See also W88-05546) (Author's abstract)
W88-05545

**CONCRETE-FACED ROCKFILL DAM: II. DESIGN,**
J. B. Cooke, and J. L. Sherard.
Journal of Geotechnical Engineering (ASCE) JGENDZ, Vol. 113, No. 10, p 1113-1132, October 1987. 3 fig, 41 ref.

Descriptors: *Rockfill dams, *Dam design, *Dam construction, *Rocks, *Concretes, Dams, Concrete-faced dams, Dam foundations, Construction, Dam stability, Reinforcing, Grouting, Reinforced concrete, Construction materials, Construction joints, Foundation rocks, Design criteria, Specifications.

A discussion of and opinions on the main details of design and construction for the concrete-face rockfill dam, including toe slab foundation treatment, dimensions, reinforcing, and grouting; face slab thickness, concrete quality, reinforcing, joints, and construction; the parapet wall and camber; and rockfill embankment foundation treatment, zoning, rock grading rock quality, and construction, are presented. Current practice and recent trends are assessed and commented upon. Empirically derived specifications are offered. (See also W88-05545) (Author's abstract)
W88-05546

**GEOLOGICAL INTERPRETATION OF WELL LOGS,**
Rider-French Consulting Ltd., Cambridge (England).
For primary bibliographic entry see Field 7C.
W88-05782

**REGIONAL DOUBLE-POROSITY SOLUTE TRANSPORT IN THE CULEBRA DOLOMITE: AN ANALYSIS OF PARAMETER SENSITIVITY AND IMPORTANCE AT THE WASTE ISOLATION PILOT PLANT (WIPP) SITE,**
INTERA Technologies, Inc., Austin, TX.
For primary bibliographic entry see Field 5B.
W88-05852

## 8F. Concrete

**USE OF RECLAIMED WASTEWATER FOR CONCRETE MIXING,**
Nanyang Technological Inst., Singapore. School of Civil and Structural Engineering.
J.-H. Tay, and W.-K. Yip.
Journal of Environmental Engineering (ASCE) JOEDDU, Vol. 113, No. 5, p 1156-1161, October 1987. 3 tab, 8 ref.

Descriptors: *Reclaimed wastewater, *Concrete technology, *Impaired water use, *Concrete strength, Compressive strength, Wastewater, Waste disposal, Concrete.

The effects of reclaimed wastewater on concrete properties were studied using samples of reclaimed wastewater collected from the Jurong Industrial Water Works (Singapore). Concrete cubes cast in 100-mm cube molds were used to study the effect of reclaimed wastewater on concrete strength. A 1:2:4 (cement:sand:coarse aggregate) mix with a water/cement ratio of 0.6 was selected for this study. Several batches of concrete were investigated by batching each mix with 0%, 25%, 50%, 75%, and 100% of reclaimed wastewater in the total mixing water required for each batch. The concrete with 0% of reclaimed wastewater was used as the reference or control batch. The compressive strengths of concrete with various percentages of reclaimed wastewater in the total mixing water and at various ages show a general increase in compressive strengths with increased percentages of reclaimed wastewater in the total mixing water for initial curing times of 3-28 days. The data from using reclaimed wastewater and potable water to cure concrete specimens cast with 100% potable mixing water indicate that the compressive strengths of the concrete cubes cured using reclaimed wastewater are greater than the compressive strength of cubes cured using potable water. This effect is greatest during the initial curing period. There were no adverse effects on resulting compressive strengths when concrete cubes were cured in reclaimed wastewater. In fact, concrete cubes cured in this reclaimed wastewater showed a 15% increase in 28-day strength compared to those cured in potable water. The gain in compressive strengths for ages three months and beyond became insignificant. From the results obtained, concrete with improved initial compressive strength could be made with reclaimed wastewater used partially or totally for the mixing water. (Alexander-PTT)
W88-05173

**HISTORY OF WATER IN THE AMERICAN WEST: JOHN S. EASTWOOD AND 'THE ULTIMATE DAM' (1908-1924),**
Pennsylvania Univ., Philadelphia. Dept. of American Civilization.
For primary bibliographic entry see Field 8A.
W88-05205

**MONITORING BHAKRA DAM,**
Roorkee Univ. (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8G.
W88-05398

**CONCRETE-FACED ROCKFILL DAM: I. ASSESSMENT,**
For primary bibliographic entry see Field 8E.
W88-05545

**CONCRETE-FACED ROCKFILL DAM: II. DESIGN,**
For primary bibliographic entry see Field 8E.
W88-05546

**CONCRETE EXPANSION AT THE RIHAND DAM, INDIA,**
O. P. Datta.
International Water Power and Dam Construction IWPCDM, Vol. 39, No. 11, p 43-44, November 1987. 2 fig.

Descriptors: *Concrete dams, *Gravity dams, *Dams, *Concrete technology, Maintenance, Rihand dam, India, Concretes, Cracks, Leakage, Expansion joints, Expansion, Construction joints, Remedies, Resins, Epoxy resins.

The Rihand concrete gravity dam in Uttar Pradesh, India, was completed in 1962. The 92 m high dam is comprised of 61 independent, 18-22 m wide concrete blocks; the concrete used in the construction of the Rihand dam ranged in strength from 175 to 400 kg/sq cm. The powerhouse at the toe of the dam houses six 50 MW-capacity turbines, and transformers and the penstock gallery are located between the toe of the dam and the powerhouse. During 1972-73, cracks in the concrete structures and frequent tripping of the generating units due to high leakage volumes were noticed. After a detailed inspection, a mathematical model was constructed which demonstrated that repair of all structures showing stress and construction of a functional expansion joint between the penstock gallery and the powerhouse were necessary. Other remedial measures, including injection of epoxy resin, application of epoxy to the surface, and installation of porous drainpipes were recommended. It is concluded that, in spite of an alkali-aggregate reaction in the dam body, there is no immediate danger to the safety of the dam or its appurtenant works and that the reservoir may be filled to the design level. However, it is suggested that the recommended remedial measures be taken and that monitoring of the structure be continued. (Wood-PTT)
W88-05583

**INTERFACE SMEARED CRACK MODEL ANALYSIS OF CONCRETE DAMS IN EARTHQUAKES,**
Military Academy, West Point, NY. Dept. of Engineering.
R. H. Graves, and K. N. Derucher.
Journal of Engineering Mechanics (ASCE) JENMDT, Vol. 113, No. 11, p 1678-1693, November, 1987. 11 fig, 15 ref, 1 append.

Descriptors: *Cracks, *Concrete dams, *Earthquakes, *Seismic properties, *Model studies, *Concrete technology, *Mechanical failure, Dams, Dam failure, Dam stability, Strain, Engineering, Hydraulic engineering, Hydraulic structures, Algorithms, Mathematical studies.

An improved interface smeared crack method for finite element modeling of cracks in concrete is developed into a usable procedure and applied to the seismic analysis of concrete gravity dams. The method pushes back displacements in elements bordering an open-crack interface to eliminate strains normal to the crack face. The amount of pushing back is found by dividing the normal strain by the appropriate strain interpolation function derivative. Pushing-back algorithms are described for interfaces at angles to the global coordinates and for skewed elements. A biaxial tensile strain failure criterion is employed. The method is combined with a cyclic ultimate strength equivalent uniaxial strain material model to analyze the behavior of the Koyna Dam in the December, 1967 earthquake. (Author's abstract)
W88-05627

**DEVELOPMENT OF NONDESTRUCTIVE TESTING SYSTEMS FOR IN SITU EVALUATION OF CONCRETE STRUCTURES,**
Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
H. T. Thornton, and A. M. Alexander.
Available from the National Technical Information Service, Springfield, VA. 22161. Technical Report No. REMR-CS-10, December 1987. Final Report. 163 p, 63 fig, 2 tab, 78 ref, 5 plates, append.

Descriptors: *Materials testing, *Concrete, *In situ tests, *Nondestructive tests, *Ultrasound, *Acoustic mapping, Concrete construction, Concrete dams, Evaluation, Piezometry, Electrical equipment, Maintenance, Mapping.

An ultrasonic pulse-echo system was studied for the investigation and evaluation of the interior of concrete structures. The large pulse-echo transducer fabricated at Ohio State University (OSU) was obtained for study. Experimental transducers were fabricated and bandwidths were altered and optimized. Transducer area and frequency of operation were determined and various piezoelectric materials were studied; acoustic and electrical matching

were employed to optimize signal strength and signal-to-noise (S/N) ratio. The final prototype transducers were constructed of lead metaniobate (EC-82) and lead zirconate titanate (PZT-5H). The transducer area and mass was reduced by 90% and the S/N ratio was increased by 200% when compared with the OSU transducer. The pitch-catch prototype configuration was used to successfully measure the thickness of a 9-1/4-in. concrete test slab with a S/N ratio of 18. The system is presently useful for making thickness measurements on concrete pavements and floor slabs. Limited tests have shown that a metal plate and a plastic pipe can be located in a concrete slab of 9-in thickness or less. Also, a thickness measurement was made on concrete by generating wideband acoustic (sonic and ultrasonic) energy by an impact hammer and detecting the echoes with a low Q resonant receiver centered at 180 kHz. Increased emphasis is being placed on the development of underwater concrete repair techniques. The extent and location of damage must be known in order to determine what steps should be taken to correct the damage and to prepare valid cost estimates. Therefore, a high resolution acoustic mapping system was developed which will provide, without dewatering, an accurate and comprehensive evaluation of top surface wear on horizontal surfaces (such as aprons, sills, lock chamber floors, and stilling basins) where turbulent water flow carrying rocks and debris have caused erosion or abrasion damage. The results of the mapping system are presented as real-time strip charts showing the absolute relief for each run, three-dimensional surface-relief plots showing composite data from the runs in each area, contour maps of selected areas, and printouts of the individual data point values. The system is designed to operate in 5 to 30 ft of water and produce accuracies of + or - 1 ft laterally. (Lantz-PTT)
W88-05700

**IN SITU REPAIR OF DETERIORATED CONCRETE IN HYDRAULIC STRUCTURES LABORATORY STUDY,**
Brookhaven National Lab., Upton, NY. Process Sciences Div.
R. P. Webster, and L. E. Kukacka.
Available from the National Technical Information Service, Springfield, VA. 22161 as DE87-004607. Price codes: A03 in paper copy; A01 in microfiche. Technical Report REMR-CS-11, January 1988. Final Report. 31 p, 7 fig, 7 tab, 3 ref.

Descriptors: *Concrete construction, *In situ repair, *Hydraulic structures, *Concrete testing, *Maintenance, Materials testing, Pressure injection, Polymers, Cracks.

The results of a laboratory-scaled test program conducted to evaluate the effectiveness of (a) pressure injection, and (b) polymer impregnation repair techniques for use in in situ repair of cracked concrete hydraulic structures, is presented. In general, the test results indicate that pressure injection can be used to effectively restore the integrity of air-dried and water-saturated cracked concrete. Polymer impregnation can be used to improve the quality of the concrete surrounding the crack network. However, its effectiveness in sealing the crack network is dependent upon the viscosity of the impregnant being used. The two methods can be used in conjunction to effectively repair and improve the overall quality of the structure to be rehabilitated. (Author's abstract)
W88-05758

**CONSTRUCTION OF DRILLED PIER FOUNDATIONS,**
For primary bibliographic entry see Field 8A.
W88-05783

**CEMENT FIXATION STUDIES AT OAK RIDGE GASEOUS DIFFUSION PLANT,**
Oak Ridge Gaseous Diffusion Plant, TN. Process Support Div.
For primary bibliographic entry see Field 5E.
W88-05907

## 8G. Materials

**SUITABILITY OF MARINE CLAYS AS HAZARDOUS WASTE SITE LINERS,**
Maine Univ., Orono. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W88-05171

**FIELD PERFORMANCE OF CORRUGATED POLYETHYLENE PIPE,**
Ohio Dept. of Transportation, Columbus.
J. O. Hurd.
Public Works PUWOAH, Vol. 118, No. 10, p 67-69, October 1987.

Descriptors: *Materials engineering, *Pipes, *Plastics, *Culverts, *Data collections, Field tests, Polyethylene.

Corrugated polyethylene pipe has been used as small culvert replacement by the Ohio Department of Transportation on a provisional basis since 1981. Data on field performance was collected at 172 culverts during February to August 1985. Several conclusions were drawn from the data. Smaller diameter pipes (12- and 15-in) are much less installation-proof than 18- and 24-in culverts. There is no increase in pipe deflection after 2-4 years in culverts with small to moderate initial deflections (<10%). Polyethylene pipe appears to be resistant to abrasive flows. Shallow cover and heavy truck traffic do not appear to damage the structure. Exposed ends are susceptible to damage by mowers and maintenance equipment, but sunlight does not adversely affect them. If 12- and 15-in pipes are used, the wall thickness should be increased, and they should be securely anchored in the trench during backfill. Culverts with moderate to large deflection (>10%) should be inspected periodically for any increase in deflection. Exposed ends should be protected under minimal cover conditions. (Cassar-PTT)
W88-05344

**SPILLWAY CHUTE AERATION,**
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
For primary bibliographic entry see Field 8B.
W88-05395

**MONITORING BHAKRA DAM,**
Roorkee Univ. (India). Dept. of Civil Engineering.
S. S. Saini.
International Water Power and Dam Construction IWPCDM, Vol. 40, No. 1, p 29-34, January 1988. 7 fig, 7 tab, 6 ref.

Descriptors: *Dam stability, *Dams, *Monitoring, *Measuring instruments, Concrete dams, Gravity dams, Bhakra dam, India, Instrument failure, Finite element method, Mathematical studies, Deflection, Stress, Grouting, Temperature effects, Pressure-measuring instruments, Data interpretation, Prediction.

A detailed study of the structural behavior of Bhakra dam, a concrete gravity structure in India, was being carried out when it was discovered that some of the instruments installed were behaving erratically and providing inconsistent data. The finite element method was used for a theoretical analysis to obtain deflections and stresses in the dam, and this included assessing the effect of grouting of the transverse joints. All static loads, including uplift pressures and temperature effects, were taken into account. The theoretically computed stresses and deflections compared well with measurements obtained from some of the stress-meters and plumblines; it was thus possible to identify reliable instruments and use data from them to assess the future performance of the dam. (Author's abstract)
W88-05398

**BOREHOLE COLOUR TV SYSTEMS FOR UNDERGROUND EXPLORATIONS,**
Electric Power Development Co. Ltd., Tokyo (Japan).
T. Hashimoto.
International Water Power and Dam Construction IWPCDM, Vol. 40, No. 1, p 40-42, January 1988. 3 fig, 1 tab.

Descriptors: *Boreholes, *Television cameras, *Data acquisition, Geologic formations, Geologic fractures, Geologic fissures, Monitoring, Dam stability, Quality control.

A borehole inspection system, incorporating a miniature color TV camera for examining borehole wall conditions, was developed in Japan in 1982, and has recently been streamlined with the development of a simplified image analyzer and supplementary equipment for inclined holes. The system is particularly useful for ascertaining the properties of areas where core recovery is poor, or where details of strikes and dips of strata, orientations and opening widths of cracks would not be clear from ordinary core observations. The accuracy of borehole investigations is considerably enhanced by the device. Its design, and various applications to date, are described. (Author's abstract)
W88-05399

**DETECTING UNDERGROUND PIPING LEAKS,**
Groundwater Technology, Inc., Annapolis Junction, MD.
For primary bibliographic entry see Field 5A.
W88-05478

**PIPE-LINING A PIPELINE,**
Hart Crowser, Inc., Anchorage, AK.
P. M. Douglass.
Civil Engineering CEWRA9, Vol. 57, No. 12, p 50-52, December 1987.

Descriptors: *Hydraulic structures, *Pipelines, *Linings, *Tunnel linings, Concrete, Anchorage, Alaska, Water distribution.

Thin core prestressed concrete cylinder pipe was installed as the liner in a water supply tunnel supplying Anchorage, Alaska. The 8,500-ft long 72-in inside diameter soil tunnel is 80-200 ft below the surface. The liner includes a hydrostatically tested heavy welded steel cylinder with steel joint rings at both ends. The 24-ft sections are connected by flush joint bell and spigot ends with double O-ring seals. A corrosion detection system is built into the lining. Electrical continuity is maintained with jumper straps. The core and wire are coated with pneumatically applied dense cement mortar to reduce corrosion. Higher material costs for this liner are counterbalanced by speed of installation and ease of backfill. (Cassar-PTT)
W88-05483

**MICROCAD: PUSHING THE LIMITS,**
P. Di Vietro.
Civil Engineering CEWRA9, Vol. 58 No. 1, p 56-58, January 1988. 3 fig.

Descriptors: *Hydraulic structures, *Engineering, *Dam design, *Design criteria, *Drafting, *Computer programs, Microcad, Dam construction, Channels, Dams, Erosion control, Channels.

Computer software allows rapid preparation of complicated engineering drawings for a variety of projects. Drawings for a 246-ft-high concrete block dam were produced at the rate of 25 per week per person instead of the customary 2 per week per person. The Soil Conservation Service uses the software to design small dams, channels, erosion control practices, survey data work, earthwork, computations, and mine reclamation work. Seven to ten working days were saved when a 7.2-mile channel surveying project took only 6 days. (Cassar-PTT)
W88-05487

**DYNAMIC EFFECTIVE STRESS FINITE ELEMENT ANALYSIS OF DAMS SUBJECTED TO LIQUEFACTION,**

Bureau of Reclamation, Denver, CO. Engineering and Research Center.
For primary bibliographic entry see Field 8A.
W88-05695

EVALUATION OF VERTICAL MOTION SENSORS FOR POTENTIAL APPLICATION TO HEAVE CORRECTION IN CORPS HYDROGRAPHIC SURVEYS,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 7B.
W88-05708

NONLINEAR RESPONSE OF CONCRETE GRAVITY DAMS TO STRONG EARTHQUAKE-INDUCED GROUND MOTION,
JAYCOR, Vicksburg, MS.
For primary bibliographic entry see Field 8A.
W88-05755

## 8I. Fisheries Engineering

ASSESSMENT OF FISH PASSAGE TECHNOLOGY APPLICABLE TO JOHN SEVIER DETENTION DAM,
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
R. W. Pasch.
Available from the National Technical Information Service, Springfield, VA 22161, as DE87-900617. Price codes: A02 in paper copy, A01 in microfiche. Tennessee Valley Authority Report No. TVA/ONRED/WRF--87/5, December 1986. 3 p.

Descriptors: *Fish passages, *John Sevier Dam, Sauger, Paddlefish, Regulations, Technology.

The US EPA issued a renewed National Pollutant Discharge Elimination System (NPDES) permit for the Tennessee Valley Authority's (TVA's) John Sevier Fossil Plant (JSF) on April 15, 1986. Part III H of that permit requires TVA to follow progress and report annually on developments in fish passage technology applicable to moving sauger and paddlefish upstream and downstream of the John Sevier detention dam (DAM). This is the first annual report of TVA's ongoing examination of such technology, and includes brief discussions on upstream passage, and downstream passage. (Lantz-PTT)
W88-05717

RESEARCH AND DEVELOPMENT OF FISH PASSAGE TECHNOLOGY,
Tennessee Valley Authority, Knoxville. Div. of Air and Water Resources.
P. A. Hackney.
Available from the National Technical Information Service, Springfield, VA. 22161, as DE87-900618. Price codes: A02 in paper copy, A01 in microfiche. Report No. TVA/ONRED/WRF--87/4, December 1986. 2 p.

Descriptors: *Fish passages, *Research priorities, Fish ladders, Salmon, Shad, Herring, Paddlefish, Walleye, Fish migration, Warm water fish.

Any fish passage provided at TVA's John Sevier Fossil Plant (JSF) would involve only warm water species. Warm water fish passage requirements differ substantially from those of salmon for which such technology has long been available. For instance, adults must be passed both upstream and downstream since they do not die after spawning as do salmon. Also, drifting eggs and larvae, and fingerlings of warm water species must be safely passed downstream, not simply outmigrating smolts as for salmon. Although some anadromous (marine) warm water species (e.g., American shad, blueback herring) are currently passed upstream and downstream through structures deliberately built for that purpose, effectiveness of this technology for passage of adults and young of potential target species (e.g., paddlefish and sauger/walleye) in Cherokee Reservoir is unproven. Upstream passage of the JS target species is known to occur for one or more of the available passage structures, but relative passage efficiencies (i.e., proportion of the migrating population) have not been investigated. Downstream passage is by far the larger and more poorly understood subject of fish migration and should be investigated first. Initial research should center on basic biological responses by various life stages of the target species to flow velocity, turbulence, shear forces, etc., encountered during downstream transport in existing water control structures. Currently, the Electric Power Research Institute is conducting research on downstream fish passage. Although this research presently is directed mainly at salmonids, plans are to expand this effort to include warm water species. (Lantz-PTT)
W88-05751

# 9. MANPOWER, GRANTS AND FACILITIES

## 9C. Research Facilities

METHOD FOR IDENTIFYING WATER RESOURCES RESEARCH NEEDS AND SETTING PRIORITIES AMONG THEM,
Vanderbilt Univ., Nashville, TN. Dept. of Environmental and Water Resources Engineering.
For primary bibliographic entry see Field 6B.
W88-05201

## 9D. Grants, Contracts, and Research Act Allotments

FISCAL YEAR 1986 INSTITUTE PROGRAM REPORT (ARKANSAS WATER RESOURCES RESEARCH CENTER).
Arkansas Univ., Fayetteville. Water Resources Research Center.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-132774/AS. Price codes: A03 in paper copy; A01 in microfiche. Contract No. 14-08-0001-G-1212. Project No. USGS G-1212-01. Institute Program Report G1212-01, June 1987. 34 p.

Descriptors: *Water Research Institute, *Research, *Information transfer, *Training, *Arkansas, Nutrient cycles, Acid deposition, Nitrogen, Nitrate, Groundwater management, Optimization, Soil, Chlorinated pesticide, Geohydrology, Drinking water, Septic tanks, Household chemicals, Algae, Taxonomy, Simulation, Education.

Arkansas' major water problems are floods, droughts, water quality, groundwater mining, institutional arrangements, laws, financing, environmental concerns and public awareness. From this generalized list of problems, a more specific list was developed by the Technical Advisory Committee to provide goals and priorities for the principal investigators. Specific areas for research include four projects on groundwater pollution, one project on groundwater management and one project on surface water quality. The groundwater pollution projects include the effects of household chemicals on septic tanks, the effects of various land uses on the groundwater quality in carbonate terrain, the movement of organic pollutants in groundwater and estimating ground and surface water pollution from the land application of poultry litter. One project covers the development of a combined quantity and quality model for optimal groundwater management. The other research project covers the chemical properties of soils and streams in natural and disturbed forest ecosystems. The technology transfer projects include water management simulator presentations and qualitative and quantitative aquatic algal data compilation for macrotrends. In these research and technology transfer projects, fifteen graduate and undergraduate students received training. (Mack-U. AR, WRRC)
W88-05222

FISCAL YEAR 1986 PROGRAM REPORT (NORTH DAKOTA WATER RESOURCES RESEARCH INSTITUTE),
North Dakota Water Resources Research Inst., Fargo.
R. C. Schnell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-132782/AS. Price codes: A03 in paper copy; A01 in microfiche. Contract No. 14-08-0001-G1244. Project No. USGS G1244-01. NDWRRI Annual Report No. G1244-01, July 1987. 31 p.

Descriptors: *Water Research Institute, *North Dakota, *Training, *Information transfer, *Research, Contamination, Groundwater, Picloram, Sulfometuron, Pesticide leaching, Lysimeters, Alachlor, Metolachlor, Atrazine, Simazin, Herbicides, Metalion complexes, Detoxication, Glyphosate, Glufosinate, Iron, Nickel, Copper, Lasers, Analyses, Fluorescence, Critical depth, Critical salinity, Soil salinization.

Research projects selected for funding in FY86 have been concerned with chemical evolution of water dissolved materials as the water moves through the vadose zone and the ultimate effect this has on groundwater quality. The projects dealt with the fate and effects of pesticides commonly used in North Dakota and with the salinization process in high water table cropland. Experiments have shown that many pesticides are found in ground and surface waters but in concentrations much lower than would be expected to produce a health hazard. Experiments concerning critical salinity in groundwater produced values less than those required to result in soil salinization. Critical depth values vary between 50 - 60 inches. Information transfer activities included: scientific manuscripts, seminars, presentations at national meetings, and educations workshops. Approximately 15 graduate students at the M.S. (3) and Ph.D. (6) levels were supported by funding under this grant. (USGS)
W88-05224

FISCAL YEAR 1986 PROGRAM REPORT (TEXAS WATER RESOURCES INSTITUTE),
Texas A and M Univ., College Station. Water Resources Inst.
W. R. Jordan.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-132790/AS. Price codes: A03 in paper copy; A01 in microfiche. Contract No. 14-08-0001-G1254. Project No. USGS G1254-01. Program Report G1254-01, October 1987. 30 p.

Descriptors: *Water Research Institute, *Research, *Information transfer, *Training, *Texas, Oxygen transfer, Water quality management, Estuarine environment, Rainfall-runoff, Water conservation, Land management, Dryland farming, Groundwater pollution, Wastewater management, Land disposal, Water use forecasting, Computer models, Short-term planning, Reservoir operation, Flood control, Conservation storage, Data aquisition, Data storage and retrieval, Water analysis.

The Institute's 1986 program addressed problems related to water quality, use of rainfall and wastewater in agriculture and management of water resources. Coastal bays and estuaries receive wastes from streams, rivers, municipal and industrial centers in coastal areas. Accurate estimates of gas exchange rates allow prediction of the movement of pollutants and oxygen thereby increasing our ability to estimate loading capacities for wastes. A combination tracer gas-dye technique appears promising for use in bays and estuaries. Benefits from furrow diking were estimated by combining simulation models for runoff and crop growth and yield. Results suggest this technology is applicable to about 3.5 million ha of cropped land in five areas in Texas and a possible net benefit of $50 million to farmers annually. Land application of wastewater is currently practiced at over 220 locations in Texas. Results of a survey established that operators in charge of municipal wastewater systems could not answer basic questions about land treatment systems. Recommendations will be developed for safe operation of land application systems. A water demand forecast model, WATFORE, was modified to allow on-site calibration by water utility personnel using local

weather data. A new microcomputer package called WATCAL was developed for automatic calibration of WATFORE parameters. Applied to an analysis of water conservation programs, the model confirmed savings of up to 30%. A 12-reservoir system in the Brazos River Basin is being studied to quantify benefits from system operation as opposed to individual reservoir operation. System firm yields were found to be nearly double the sum on individual reservoir firm yields. A Water Analysis, Technical Evaluation and Retrieval System (WATERS) was developed and implemented by the Soil and Water Testing Lab and will provide for storage and retrieval of a water quality data base for researchers and extension specialists. (Jordan-Texas A&M U, WRI)
W88-05225

**FISCAL YEAR 1986 PROGRAM REPORT (NEW HAMPSHIRE WATER RESOURCES RESEARCH CENTER),**
New Hampshire Univ., Durham. Water Resources Research Center.
T. P. Ballestero.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-132808/AS. Price codes: A03 in paper copy; A01 in microfiche. Contract No. 14-08-0001-G1239. Project No. USGS G1239-01. Program Report G1239-01, August 1987. 29 p.

Descriptors: *Water Research Institute, *Research, *Information transfer, *Training, *New Hampshire, Herbicide, Forest Watersheds, Contaminant transport, Gasoline, Biodegradation, Groundwater, Acid rain, Water treatment, Sulfate, Water supply development, Rural areas, Cost analysis, Stream acidification, Streams, Stream drift, Hydrogen ion concentration.

This report covers the activities of the New Hampshire Water Resources Research Center for the period July 1, 1986 through June 30, 1987. The results of six research projects are briefly discussed. Projects include: fate of aerially applied herbicide; biodegradation of gasoline; effects of acid rain on water treatment; cost evaluation of rural water systems; attitudes towards water quality protection; and pH and aluminum effects on stream insects. (Ballestero-U. NH, WRRC)
W88-05226

**FISCAL YEAR 1986 PROGRAM REPORT (PUERTO RICO WATER RESOURCES RESEARCH INSTITUTE),**
Puerto Rico Univ., Mayaguez. Water Resources Research Inst.
L. A. del Valle.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-132824/AS. Price codes: A03 in paper copy; A01 in microfiche. Contract No. 14-08-0001-G1249. Project No. USGS G1249-01. Program Report G1249-01, July 1987. 16 p.

Descriptors: *Water Research Institute, *Training, *Research, *Information transfer, *Puerto Rico, Industrial wastewater, Incineration, Sludge disposal, Recreation, Social impact, Reservoir sites, Sludge digestion, Composting, Simulation, Wastewater irrigation, Sludge utilization, Soil amendment.

The Puerto Rico Water Resources Research Institute's program during FY 1986 included four research projects and two technology transfer activities. Three out of the four research projects were focused on the sludge management problems being encountered by the Commonwealth's wastewater treatment plants. The fourth one was a study on the social impact and recreational use of inland water reservoirs, which was of much interest to both Puerto Rico's Department of Natural Resources and the Environmental Quality Board. Two of these projects, one on the use of wastewater and organic sludge as soil amendment and the other just mentioned on the social impact and recreational use of reservoirs, have been completed and are in the final report writing stage. Still in progress are a study on the management of sludge from the Island's regional industrial wastewater treatment plant and a project on simulation of the sewage sludge composting process. The technology transfer activities developed were the preparation of an educational water resources slide program (still in progress) and a one-day seminar on Puerto Rico's groundwater resources, sponsored jointly with the Puerto Rico Water Resources Association. (del Valle-Univ. Puerto Rico, WRRI)
W88-05228

**FISCAL YEAR 1986 PROGRAM REPORT. (OKLAHOMA WATER RESOURCES RESEARCH INSTITUTE),**
Oklahoma Water Resources Research Inst., Stillwater.
N. N. Durham.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-132832/AS. Price codes: A03 in paper copy, A01 in microfiche. Contract No. 14-08-001-G1246. Project No. USGS G1246-01. Program Report G1246-01, August 1987. 42 p, 8 refs.

Descriptors: *Water Research Institute, *Research, *Information transfer, *Oklahoma, Landfills, Groundwater, Groundwater pollution, Groundwater movement, Regulations, Permits, Model studies, Geophysics, Hydrology, Industrial wastes, Adsorption, Trace metals, Geochemistry, Water properties, Micelles, Microemulsions, Rill erosion, Rainfall simulator, Sediment transport, Probability process, Risks, Frequency analysis, Design criteria, Probability distribution, Design flood.

The major thrust of the Oklahoma Water Resources Research Institute during the 1986 program year involved activities related to the five year research program and information transfer. Research projects funded by the OWRRI to address these problems and issues included: the development of techniques for the characterization of landfill site suitability in Oklahoma; development of a dielectric sampling method to measure water saturation profiles; metal ion adsorption by solid phase mixtures representative of soil and aquatic systems; a study of computer models for the interactions of surfactant aggregates in solution with aqueous solvent; transport of eroded soil particles; and development of procedures to incorporate risk analyses in the design processes for water resources facilities. (Durham-OK St U., WRRI)
W88-05229

**FISCAL YEAR 1986 PROGRAM REPORT (HAWAII WATER RESOURCES RESEARCH CENTER),**
Hawaii Univ., Honolulu. Water Resources Research Center.
L. Lau.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-142765/AS. Price codes: A03 in paper copy; A01 in microfiche. Contract No. 14-08-0001-G1418. Project No. USGS G1418-01. Program Report G1418-01, September 1987. 34 p, 3 figs, 11 ref.

Descriptors: *Research, *Information transfer, *Training, *Hawaii, *Water Research Institute, Water rights, Enteroviruses, Infiltration, Drip irrigation, Viruses, Water quality, Drought, Water management, Groundwater, Model studies, Frequency analysis.

The Hawaii State water code was enacted in 1987, 9 yr after the 1978 State Constitutional Convention mandate. The result of many years of struggle between contesting interests, the document reflects major compromises and omissions; thus, it remains to be seen how well this legal framework can meet problems and recognize management opportunities. Another issue of valuable learning experience for regulatory and resources management was the organic contamination of Oahu's groundwater, for which online water quality control measures on a continuing basis were taken and preventive measures were requested from researchers to avoid a repeat occurrence. A third issue focused on the problem of the 1984 drought, its recurrence in a humid tropics region, and ameliorating actions other than mandatory or voluntary conservation. Three SWRIP projects address priority I (water supply sources): project 03 develops a highly sensitive and rapid method (nitrocellulose membrane for enzyme immunoassay, NC-CIA) to detect human enteropathogenic viruses in water; 08 identifies the 1983-1984 drought as the most severe (of seven major droughts on Oahu since 1972) in the past 100 yr.; and 06 develops an urban water pricing economic strategy for urban water supply in drought emergencies for Oahu. Two projects focus on priority VII (Asia-Pacific islands water management): project 02 evaluates the law of 'just compensation' set forth in the landmark McBryde v. Robinson litigation for adoption of a water code for American Samoa; and 07 develops a conceptual model and adopts a computer model (SUTRA) to address the problems of groundwater development of a thin freshwater lens for Laura in Majuro Atoll, Marshall Islands. Two other projects deal with natural phenomena affecting water management: project 04 develops a method for physical and mathematical evaluation of three-dimensional water infiltration into soil (priority VIII; hydrology) that occurs in drip irrigation; and 05 evaluates the cidal effects of Hawaii's sunlight on bacteria indicators and viruses in natural waters (priorities II (coastal water environment), III (instream water uses)) and identifies conditions of its maximum effectiveness. (Fujimura-HI U., WRRC)
W88-05230

**FISCAL YEAR 1986 PROGRAM REPORT, (VERMONT WATER RESOURCES RESEARCH CENTER),**
Vermont Water Resources Research Center, Burlington.
A. W. McIntosh.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-142773/AS. Price codes: A03 in paper copy; A01 in microfiche. Contract No. 14-08-001-G1256. Project No. USGS G1256-01. Program Report, August 1987. 22 p.

Descriptors: *Water Research Institute, *Research, *Training, *Information transfer, *Vermont, Surface water, Water pollution, Toxic substances, Microbial indicators, Wetlands, Water quality data.

Protection of water resources within Vermont was the major focus of the 1986 Vermont Water Resources Research Center's program. One research project discussed approaches for managing various sources of potentially toxic priority pollutants within the Lake Champlain basin, while a second assessed the public's perception of various issues related to the protection of wetlands within Vermont. A third research project focused on the development of new techniques for determining the microbial quality of surface waters. Information transfer activities included the organization of a workshop on toxics substances in the Lake Champlain basin, the computerization of a workshop on toxics substances in the Lake Champlain basin, the computerization of a water quality data base for Lake Champlain and a study of the public's perception of key water resources issues within Vermont. (USGS)
W88-05231

**FISCAL YEAR 1986 PROGRAM REPORT (INDIANA WATER RESOURCES RESEARCH CENTER),**
Purdue Univ., Lafayette, IN. Water Resources Research Center.
J. H. Cushman.
Available from the National Technical Information Service, Springfield, VA 22161 as PB88-139779/AS. Price codes: A03 in paper copy; A01 in microfiche. Project No. USGS G1224-01. Contract No. 14-08-0001-G1224. 22nd Annual Report - G1224-01, August 1987. 39 p, 4 tab.

Descriptors: *Water Research Institute, *Indiana, *Training, *Information transfer, Storm water, Aquatic plants, Wastewater, Groundwater flow, Model studies, Urban drainage, Growth rates, Dewatering sludge, Flow equations.

The 1986 program of the Indiana Water Resources Research Center, located at Purdue University, has revolved around four research projects and a technology transfer program. In addition to the research and technology transfer activities, the Center has proposed several joint ventures with various state agencies. Two of these initiatives, which are currently under study, are: (1) the possibility of establishing a water chemistry laboratory and, (2) conducting jointly sponsored, detailed hydrogeochemical studies of several Indiana counties. M. H. Houck, J. R. Wright, J. W. Delleur, and J. M. Bell of Purdue's Department of Civil Engineering developed an expert system for rehabilitating urban drainage infrastructure using the 'SWMM' (Storm Water Management Model). C. A. Lembi of Purdue University's Department of Botany and Plant Pathology conducted a study on aquatic plant growth regulation to see if antigibberellin-type regulators could reduce the rate of stem elongation in submersed aquatic plants without killing the plants. Paclobutrazol was effective as a stem length inhibitor if applied at certain critical dosage levels. J. A. Caskey of the Department of Chemical Engineering at Rose-Hulman Institute of Technology conducted an investigation of the effects of conditioning agents on dewatering wastewater sludges. Results from his study are being tabulated. D. I. Leap of Purdue University's Department of Earth and Atmospheric Sciences developed a new numerical method for accurately solving the groundwater flow equations. The method combines analytical solutions with the BIEM. The technology transfer program involved meetings with various national, state, and private entities, seminars and invited presentations to various groups, and Center newsletters. (Cushman-Purdue U., WRRI)
W88-05238

# 10. SCIENTIFIC AND TECHNICAL INFORMATION

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**TRACE METAL INTERACTIONS WITH MICROBIAL BIOFILMS IN NATURAL AND ENGINEERED SYSTEMS,**
Cornell Univ., Ithaca, NY. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
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**MODELING MICROBIAL FATE IN THE SUBSURFACE ENVIRONMENT,**
Robert S. Kerr Environmental Research Lab., Ada, OK. Subsurface Processes Branch.
For primary bibliographic entry see Field 5B.
W88-05471

## 10F. Preparation Of Reviews

**NEW ROUTES BUOY EFFORTS TO TRIM HEAVY-METAL WASTES,**
For primary bibliographic entry see Field 5D.
W88-05131

**MATHEMATICAL MODELING OF SOLUTE TRANSPORT IN THE SUBSURFACE,**
Battelle Memorial Inst., Columbus, OH. Environmental and Health Sciences Section.
For primary bibliographic entry see Field 5B.
W88-05425

**INSTITUTIONAL AND HUMAN RESOURCE DEVELOPMENT FOR WATER QUALITY-CONTROL PROGRAMS IN DEVELOPING COUNTRIES,**
Agency for International Development, Washington, DC. Office of Health.
For primary bibliographic entry see Field 5G.
W88-05426

**MICROORGANISMS IN MUNICIPAL SOLID WASTE AND PUBLIC HEALTH IMPLICATIONS,**
Environmental Protection Agency, Cincinnati, OH. Hazardous Waste Engineering Research Lab.
For primary bibliographic entry see Field 5B.
W88-05469

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